Vol. II

TRANSCRIPT OF RECORD

Supreme Court of the United States

OCTOBER TERM, 1935

No. 388

A. G. TRIPLETT, R. M. TRIPLETT, A. NELSON, ET AL., PETITIONERS,

vs.

PERCIVAL D. LOWELL, FRANCIS W. DUNMORE, AND DUBILIER CONDENSER CORPORATION

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE FOURTH CIRCUIT

PETITION FOR CERTIORARI FILED AUGUST 21, 1935.

CERTIORARI GRANTED DECEMBER 9, 1935.

SUPREME COURT OF THE UNITED STATES

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ON PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE FOURTH CIRCUIT.

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JUDD & DETWEILER (INC.), PRINTERS, WASHINGTON, D. C., JULY 25, 1935.

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Referred to in Paragraph 6 of the Bill of Complaint

Lowell, et al., 1,455,141

439

May 15, 1923. 1,455,141

P. D. LOWELL ET AL

RADIO RECEIVING APPARATUS

Filed March 27, 1922 2 Sheets-Sheet 1

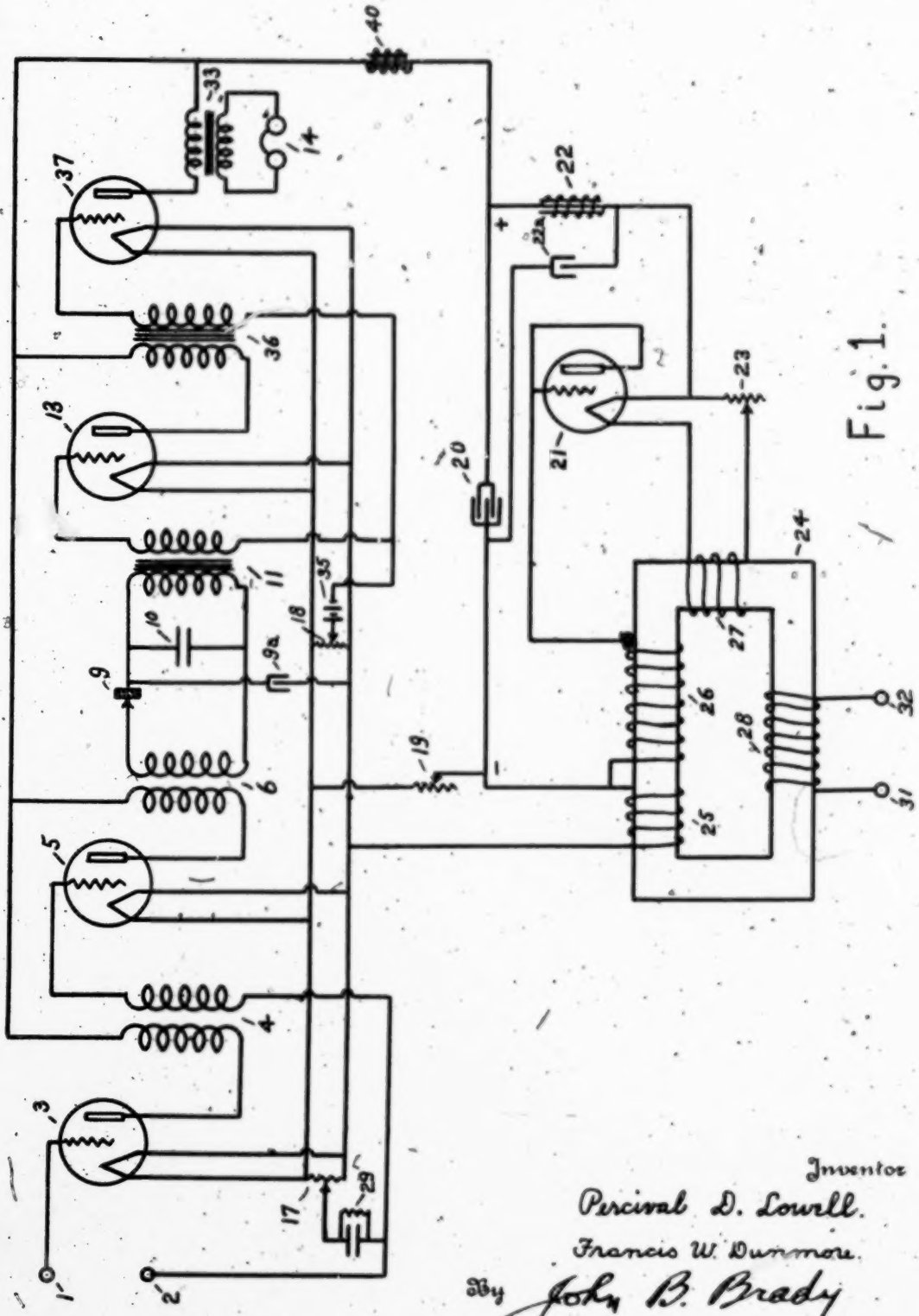

Fig. 1.

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440 May 15, 1923. 1,455,141

P. D. LOWELL ET AL

RADIO RECEIVING APPARATUS

Filed March 27, 1922 2 Sheets-Sheet 2

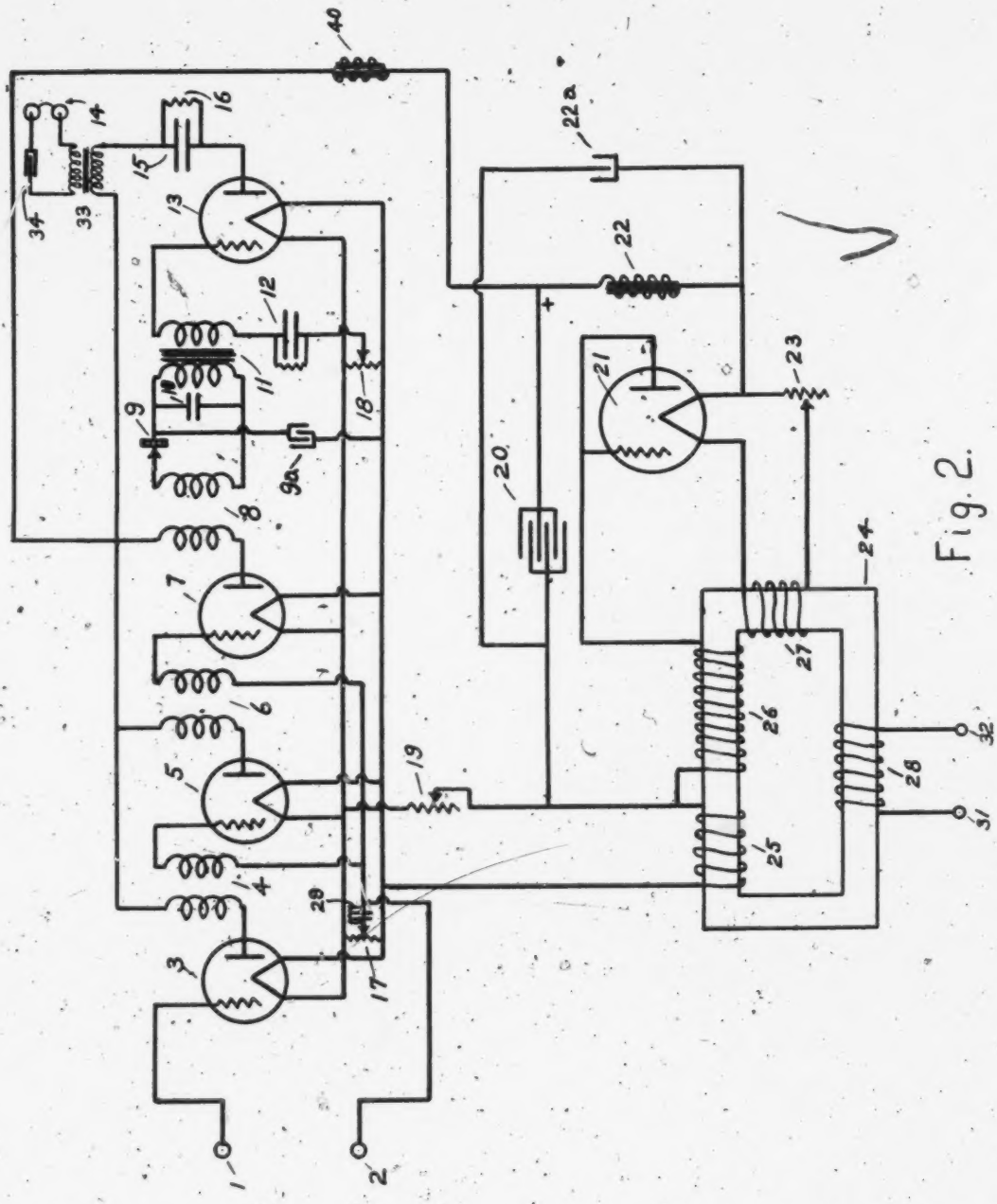

Fig. 2.

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Percival D. Lowell

Francis W. Dunmore

By John B. Brady

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UNITED STATES PATENT OFFICE.

PERCIVAL D. LOWELL AND FRANCIS W. DUNMORE, OF WASHINGTON, DISTRICT OF COLUMBIA.

RADIO RECEIVING APPARATUS.

Application filed March 27, 1922. Serial No. 547,111.

To all whom it may concern:

Be it known that we, PERCIVAL D. LOWELL and FRANCIS W. DUNMORE, citizens of the United States, residing at Washington, District of Columbia, have invented certain new and useful Improvements in Radio Receiving Apparatus, of which the following is a specification.

Our invention relates broadly to radio telegraph and telephone receiving apparatus and more particularly to a circuit arrangement for such receivers.

The object of the invention is to provide a receiver unit of maximum sensitivity employing thermionic vacuum tubes with their circuits supplied with energy from the standard alternating current residence lighting power.

Another object of the invention is to provide both radio and audio frequency amplification at the receiver and means for energizing the power circuits of the amplifier stages from the standard alternating current residence lighting power without interference in the reproducing receivers from the hum of the alternating current power supply.

A further object of the invention is to provide a circuit arrangement for a receiver wherein both the radio and audio frequency currents are amplified by means of electron tubes, a crystal detector used as a rectifier, the necessary filament and plate voltages being supplied by the standard alternating current residence lighting power, the residual hum in the telephone receivers being balanced out or neutralized by means of voltage dividers and other devices in the receiver circuits.

A still further object of the invention is to provide means in a radio receiver for transforming the alternating current power supply into currents suitable for the various circuits of the radio and audio frequency stages of the vacuum tube amplifiers and means for rectifying currents and obtaining a steady source of direct current potential for the plate circuits of the vacuum tubes.

Electron tube amplifiers form an important part of practically all radio receiving sets now, except the most simple types. Such amplifiers are in fact necessary to receive distant stations, or when using coil antennæ. For good operation, amplifier tubes require for the filament a source of voltage of very constant value (usually about 6 volts) and for the plate a source of voltage of from 40 to perhaps 300 volts. The filament voltage is usually supplied by storage cells, and the plate voltage by dry cells. The maintenance of these cells in operating condition, especially the storage cells, is often a source of much difficulty and annoyance. The storage cells are necessarily bulky and heavy, require constant attention to maintain proper charge and density of electrolyte, give off injurious acid or other fumes, and are subject to considerable variations of voltage during the period of discharge. The development of a receiver employing an amplifier which can be supplied from the ordinary 110-volt alternating current lighting mains is of considerable practical importance, since it eliminates the great practical difficulty of maintaining storage cells. The amplifier using such alternating current supply has the important advantages of reliability, convenience, and cheapness both in first cost and operating cost.

The invention will be more clearly understood by reference to the following specification and the accompanying drawings in which:

Figure 1 is a schematic wiring diagram of a complete receiver embodying two stages of radio frequency amplification, a crystal detector, and two stages of audio frequency amplification; and Fig. 2 is a wiring diagram of a modified form of our receiver including three stages of radio frequency amplification, a crystal detector, and one stage of audio frequency amplification.

It will be understood that the principles of our invention may be embodied in various forms and that details are not material. The present embodiment of the invention, therefore, is to be considered as merely indicative. The form illustrated in the drawing and hereinafter described in detail has been found to be one of the practical embodiments and capable of efficient operation and practical in construction.

The receiver of the present invention is particularly adapted for general use in receiving radio broadcasting concerts, news, lectures, music and messages. The receiver does not require the usual primary or sec-

ondary batteries as a source of power for the filament and plate circuits of the vacuum tube amplifiers. A power transformer forms a part of the apparatus and power from the standard alternating current residence lighting circuit is supplied to the primary winding of the transformer. The transformer has a plurality of secondary windings wound in such ratio as to give proportionate current and voltage values as required by the filament and plate circuits of the amplifiers. A rectifier of the two electrode valve type is employed for obtaining a direct current for the plate supply to the tubes and the filament of this valve is also supplied with heating current obtained from one of the proportionate secondary windings of the transformer. The control of the filament temperature of this valve affords means for regulating the potential supplied to the plates of the tubes.

Heretofore in the art successful results have not been obtained by employing the alternating current residence lighting circuit as a source of power supply due to the persistent and predominating interference offered in the reproducing telephones by the hum of the alternating current. We have discovered that this residual hum can be eliminated and in the present receiver the telephones are to all practical purposes absolutely silent as far as any residual hum from the alternating current power supply is concerned. To obtain this result we employ a rectifier of the crystal detector type, although other forms of rectifiers may be readily employed, interposed in circuit after the stages of radio frequency amplification and before the stages of audio frequency amplification. The use of a crystal detector is not as objectionable as it would seem on first consideration, as the radio-audio amplification in association with this form of rectifier makes possible a quick adjustment due to the fact that most any point on a sensitive crystal will bring in a signal of sufficient intensity for all practical purposes. The employment of a crystal detector in place of the electron tube detector reduced the 60-cycle hum very considerably. When an electron tube is used as the detector, there is impressed on both the plate and the filament a 60-cycle A. C. voltage which although small, becomes very objectionable when amplified by one or two stages of audio-frequency amplification. When the crystal detector is used, no 60-cycle voltage is supplied to the detector circuit. The radio-frequency transformer whose output is delivered to the detector circuit prevents the passage in any appreciable amount of 60-cycle current supplied to the radio-frequency stage and such voltages are not present in the crystal detector circuit and do not reach the input of the audio-frequency stage. In predetermined parts of the circuits of the vacuum tube amplifier voltage dividers, balancing resistances, leak resistances, condensers and choke coils are employed to balance out or neutralize any residual hum and prevents its passage into the telephone receivers.

Referring more particularly to Fig. 1 of the drawings a receiver circuit is shown adapted for connection with a variably tuned circuit and thence with an antenna ground system or with a coil antenna. The receiver illustrated comprises an amplifier circuit with two radio frequency stages, a crystal detector and two audio frequency stages. The filaments of all the tubes are connected in parallel and are lighted by alternating current voltage supplied from the secondary winding 25 of the transformer 24, their brilliancy being controlled by the rheostat 19. The primary winding of transformer 24 is shown at 28, the alternating current power supply being connected to the terminals 31 and 32.

Winding 26 of transformer 24 supplies high voltage alternating current which is rectified by the electron tube 21, smoothed out by choke coil 22 and condensers 20 and 22^a, which are about 2 microfarads capacity. The choke coil 40 may be used as a voltage limiting device in the plate circuit which serves to hold the plate voltage at the proper value regardless of the brilliancy of the electrodes of rectifier tube 21. This provides a high voltage direct current which is suitable for the plates of the amplifier tubes. The filament of the rectifier tube 21 is lighted from winding 27 of transformer 24. The rheostat 23 varies the brilliancy of the rectifier filament, which in turn controls the direct current voltage output.

The input terminals to the amplifier are shown at 1 and 2, being connected to the grid of tube 3 and terminal 2 being connected to the slider of balancing resistance 17 through a grid leak and shunting condenser indicated as a unit at 29, the latter serving to keep the grids of tubes 3 and 5 at the proper operating voltage, making the tube more suitable for amplifying. In the unit 29 the condenser is about 1 microfarad capacity and the shunting resistance is about 1 megohm. The balancing resistance 17 is about 200 ohms and is connected directly across the filament line and serves to stabilize the normal grid voltage. A similar balancing resistance 18 performs a similar function for the grids of tubes 13 and 37. The slider of balancing resistance 18 is connected through a dry battery 35 to grid of tubes 13 and 37. This battery impresses a suitable negative voltage on the grids making the tubes more suitable for amplifying. As this battery furnishes grid voltage only the power consumed is negligible. It is therefore of the small flashlight battery type and will con-

tinue effective for a period equivalent to its normal shelf life.

The plate circuit of tube 3 is coupled to the grid circuit of tube 5 by means of the radio frequency transformer 4. There is some variation in the plate current of tube 3 due to the periodic variation in filament temperature but the resultant audio frequency hum does not pass through the radio frequency coupling of transformer 4 and does not reach the input of tube 5.

The secondary of radio transformer 4 is connected to grid of tube 5 and to slider of balancing resistance 17 through condenser and shunting grid leak resistance 29, the resistance 17 keeping the grid voltage steady and the condenser and shunted resistance 29 keeping the grids at the proper negative voltage for amplifying purposes.

The primary winding of radio frequency transformer 6 is connected in the plate circuit of tube 5. The secondary winding of transformer 6 is connected to the crystal detector circuit 9 and includes the primary of audio frequency transformer 11 having a radio frequency by-pass condenser 10 shunted across the winding. The end of primary winding of transformer 11 which is connected to the crystal detector 9 is also connected to the filament circuit through a suitable condenser 9^a of 1 microfarad capacity, this condenser serving to further remove the 60 cycle hum from the telephone receivers. The secondary terminals of this audio transformer 11 are connected to the grid of tube 13 and to slider of balancing resistance 18 through battery 35. Another audio frequency stage is added in a similar manner and is indicated by transformer 36 and tube 37. The telephone receivers 14 may be connected inductively to the plate circuit of tube 37 by means of telephone transformer 33 which has a one to one ratio of windings.

By adjusting the balancing rheostats 17 and 18 the voltage of all the grids may be kept at a steady value and the battery 35 provides the proper negative voltage to the grids of the audio amplifying tubes for the best amplification, while grid leak and condenser 29 serve to keep the grids of tubes 3 and 5 at the best operating voltage.

Fig. 2 shows a modified form of circuit comprising three stages of radio frequency amplification, a crystal detector, and one stage of audio frequency amplification. As in the former case the slider of balancing resistance 17 is connected through a condenser shunted by a leak resistance 29 to the grids of the radio frequency amplifying tubes. The capacity of this condenser is about one microfarad. With this condenser in the circuit as shown, the grids assume a normal voltage suitable for amplifying as derived from winding 25 of transformer 24 while the balancing resistance 17 neutralizes effect of the alternating current on the filaments. The leak resistance across condenser 29 permits any super-charge on the grids to leak off to the filaments. This connection of condenser, high resistance leak and rheostat forms one of the neutralizing means for eliminating the hum of the alternating current from the reproducing telephone receivers.

The grid circuit of the audio frequency amplifier tube 13 is connected to the slider of balancing resistance 18 through condenser and shunted leak 12, which replaces the grid battery 35 used in the former circuit. The condenser 12 is about .02 microfarads capacity.

The purpose of the condenser 12 is to allow the grid of tube 13 to assume a normal voltage suitable for amplifying while the balancing resistance 18 serves to keep the grid voltage steady with respect to the filaments. This forms another of the means for eliminating the alternating current hum from the reproducing telephone receivers.

In series with the plate circuit of tube 13 is a condenser 15 of about .02 microfarads capacity shunted by resistance 16 of about 80,000 ohms. The action of this condenser and resistance is to partially block the low frequency fluctuations in plate current, caused by the periodic change in filament temperature, while the higher frequencies pass through more easily. The 80,000 ohms resistance allows the high voltage direct current to flow to the plate. In the secondary circuit of the telephone transformer 33 and in series with the telephone receivers 14 is shown a condenser 34 of about .02 microfarads capacity which partially blocks any low frequency hum from flowing into the telephone circuit, but which allows the higher frequencies to pass through more easily. The source of filament current and plate voltage is obtained from transformer 24 and two electrode tube rectifier 21 in the manner as described in the circuit arrangement of Fig. 1.

In either of these circuits, instead of the balancing resistance across the filament line, a divided condenser circuit with suitable grid leaks shunted across the condensers may be provided and a connection taken from the center thereof to the grid circuit, or the filament current winding on the transformer may be tapped at its electrical center and lead to the grid circuit. By provision of these neutralizers and the crystal detector rectifier the operator wearing head telephone receivers 14 has no practical interference from the low frequency hum of the alternating current power supply.

The amplifier as above described is adapted to be mounted in a readily portable cabinet which may also contain suitable variable tuning apparatus and the coil aerial,

thus making a complete compact, portable, and practical receiving unit. The power transformer is provided with a flexible cord lead and this may be plugged in to a source of standard house lighting current such as 110 volts 60 cycles A. C. The filaments of the tubes are brought up to an electron emitting temperature by rheostat 19. The plate potential is regulated by varying the temperature of the filament of the rectifier tube 21 by varying the rheostat 23. Rheostats 17 and 18 are regulated to adjust the grid potential and secure neutralization of any disturbing interference from low frequency hum. The crystal detector is adjusted to maximum sensitivity and the radio telephone or telegraph signals reproduced in telephone receivers 14.

While we have described our invention in certain specific embodiments, it will be understood that modifications may be made and that no limitations upon the invention are intended beyond the scope of the appended claims.

What we claim is:

1. In an apparatus for receiving radio signals the combination of a source of signal energy, means for amplifying said energy, means for rectifying said energy, and a source of alternating current for supplying power to said amplifying means and a plurality of means in circuit with said amplifying means for eliminating the hum of said alternating current in said apparatus.

2. In an apparatus for the reception of radio signals the combination of a source of signal energy, means for amplifying said signals, means for rectifying said signals, a source of alternating current for supplying power to said amplifying means, and means connected to said amplifying and rectifying means for eliminating the hum of said alternating current in said apparatus.

3. In an apparatus for the reception of radio signals the combination of a source of signal energy, means for amplifying said signal energy at radio frequencies, means for rectifying said energy, means for amplifying said energy at audio frequencies, a source of alternating current for supplying power to said amplifying means and separate means connected to each of said amplifying and rectifying means for eliminating the hum of said alternating current in said apparatus.

4. In an apparatus for the reception of radio signals the combination of a source of signal energy, means for amplifying said energy at radio frequencies, means for rectifying said energy, means for amplifying said energy at audio frequencies, a reproducer connected to said last amplifying means, a source of alternating current for supplying power to said amplifying means, and means connected to each of said amplifying, rectifying and reproducing means for eliminating the hum of the alternating current in said apparatus.

5. In an apparatus for the reception of radio signals the combination of a source of signal energy, a plurality of vacuum tubes arranged to amplify said energy at radio frequencies, a crystal detector arranged to rectify said energy, means for amplifying and reproducing said energy at audio frequencies, a source of alternating current for supplying power to said amplifying means, and a plurality of means for eliminating the hum of said alternating current in said apparatus.

6. In an apparatus for the reception of radio signals the combination of a source of signal energy, a plurality of vacuum tubes having grid, filament and plate electrodes, circuits interconnecting said electrodes whereby said tubes amplify said signal energy at radio frequencies, a crystal detector for rectifying said energy, means for amplifying and reproducing said energy at audio frequencies, a source of alternating current for supplying power to said amplifying means, and means in each of said circuits for eliminating the hum of the alternating current in said apparatus.

7. In an apparatus for the reception of radio signals the combination of a source of signal energy, means for amplifying said energy at radio frequencies, means for rectifying said energy, means for amplifying and reproducing said energy at audio frequencies, a source of alternating current, means for rectifying said current and supplying the rectified power to the circuits of said amplifying means and separate means in different parts of said circuits for eliminating the hum of the alternating current in said apparatus.

8. In an apparatus for the reception of radio signals the combination of a source of signal energy, a radio frequency vacuum tube amplifier, a crystal detector, an audio frequency vacuum tube amplifier, circuits connecting said amplifiers with said crystal detector, a source of alternating current for supplying power to said amplifiers, and separate means in each of said circuits for eliminating the hum of the alternating current in said apparatus.

9. In an apparatus for the reception of radio signals the combination of a source of signal energy, a radio frequency vacuum tube amplifier, a crystal detector, an audio frequency vacuum tube amplifier, circuits connecting said amplifiers with said crystal detector, a source of alternating current for supplying power to said amplifiers, adjustable means in said amplifier circuits and fixed means connected to said detector circuit for eliminating the hum of said alternating current in said apparatus.

10. In an apparatus for the reception of radio signals the combination of a source of signal energy, a radio frequency vacuum tube amplifier, a crystal detector, an audio frequency vacuum tube amplifier means for reproducing the signal energy, circuits connecting said amplifiers with said crystal detector, a source of alternating current for supplying power to said amplifiers, condensers shunted by resistances connected in said amplifier circuits, and adjustable means for eliminating the hum of said alternating current in said reproducing means.

11. In an apparatus for the reception of radio signals the combination of a source of signal energy, a radio frequency vacuum tube amplifier, a crystal detector, an audio frequency vacuum tube amplifier, a reproducer connected to said audio frequency amplifier, a transformer having a primary winding and a plurality of secondary windings, a source of alternating current connected to said primary winding, said secondary windings being connected to supply power to the circuits of said vacuum tube amplifiers, and hum eliminators connected in different portions of said circuits.

12. In an apparatus for the reception of radio signals the combination of a source of signal energy, a radio frequency vacuum tube amplifier, a crystal detector, an audio frequency vacuum tube amplifier, a reproducer connected to said audio frequency amplifier, a transformer having a primary winding and a plurality of secondary windings, a source of alternating current connected to said primary winding, said secondary windings being connected to supply power to the circuits of said vacuum tube amplifiers, and separate means connected in each of the circuits of said amplifiers, detector and reproducer for eliminating the hum of said alternating current in said apparatus.

13. In an apparatus for the reception of radio signals the combination of a source of signal energy, a radio frequency vacuum tube amplifier, a detector, an audio frequency vacuum tube amplifier, a reproducer connected to said audio frequency amplifier, a transformer having a primary winding and a plurality of secondary windings, a source of alternating current connected to said primary winding, means for rectifying energy from one of said secondary windings, means for supplying the rectified energy to the circuits of said vacuum tube amplifiers, and separate means connected in each of the circuits of said amplifiers, detector and reproducer for eliminating the hum of said alternating current in said apparatus.

14. In an apparatus for the reception of radio signals the combination of a source of signal energy, a plurality of vacuum tubes having grid, filament and plate electrodes, circuits interconnecting said electrodes whereby said tubes amplify said signal energy at radio frequencies, a detector for rectifying said energy, vacuum tubes for amplifying said energy at audio frequencies, a source of alternating current, means for supplying said current to the filaments of said tubes, means for rectifying said current and supplying potential to the plate circuits of said tubes, and separate means in each of said circuits for eliminating the hum of the alternating current in said apparatus.

15. In an apparatus for the reception of radio signals the combination of a source of signal energy, a plurality of vacuum tubes having grid, filament and plate electrodes, a detector, circuits interconnecting said electrodes and said detector, a transformer having a primary winding connected to a source of alternating current, secondary windings, a two electrode valve rectifier having a filament and a plate, connections between one of said secondary windings and the filament of said rectifier, connections between another of said secondary windings and said rectifier whereby direct current is supplied to the plate circuits of said vacuum tubes, another of said secondary windings connected to supply heating current to the filaments of said vacuum tubes and a capacity and resistance connected in said plate circuits for eliminating the hum of said alternating current in said apparatus.

16. In an apparatus for receiving radio signals the combination of a source of signal energy, means for amplifying said energy, means for rectifying said energy, a source of alternating current for supplying power to said amplifying means, means for rectifying said current, and a plurality of separate means connected in circuit with said rectifying means for smoothing out the rectified current and supplying power to said amplifying means.

17. In an apparatus for the reception of radio signals the combination of a source of signal energy, a plurality of vacuum tubes having grid, filament and plate electrodes, a source of alternating current for supplying power to said tubes, a detector for rectifying said signal energy, circuits interconnecting said electrodes and said detector, and an unipolar connection including a condenser between the circuit containing said detector and said filament electrodes, and means in said circuits for eliminating the hum of the alternating current in said apparatus.

18. In an apparatus for the reception of radio signals the combination of a source of signal energy, a plurality of vacuum tubes having grid, filament and plate electrodes, a detector, circuits interconnecting said electrodes and said detector, a source of alternating current for supplying power to

said circuits, and means connected in circuit with said grid and plate electrodes for eliminating the hum of the alternating current in said apparatus.

19. In an apparatus for the reception of radio signals the combination of a source of signal energy, a plurality of vacuum tubes having grid, filament and plate electrodes, a detector, circuits interconnecting said electrodes and said detector, a source of alternating current, a two electrode valve for rectifying said current and supplying the rectified energy to the plate electrodes of said vacuum tubes, and means connected in circuit with said plate electrodes for limiting the potential supplied to said plate circuits from said two electrode valve.

20. In an apparatus for receiving radio signals the combination of a source of signal energy, means for amplifying said energy, means for rectifying said energy, means for reproducing said energy, a source of alternating current for supplying power to said amplifying means, and means connected in circuit with said reproducing means for eliminating the hum of said alternating current in the reproducing means.

21. In an apparatus for the reception of radio signals the combination of a source of signal energy, a plurality of vacuum tubes having grid, filament and plate electrodes, a source of alternating current for supplying power to said tubes, a detector for rectifying said signal energy, circuits interconnecting said electrodes and said detector, fixed means in circuit with said grid electrodes and said plate electrodes, and variable means in circuit with said grid electrodes, all of said means serving to eliminate the hum of the alternating current in said apparatus.

PERCIVAL D. LOWELL.
FRANCIS W. DUNMORE.

DISCLAIMER

1,455,141.—*Percival D. Lowell* and *Francis W. Dunmore*, Washington, D. C. RADIO RECEIVING APPARATUS. Patent dated May 15, 1923. Disclaimer filed July 8, 1933, by the patentees and the exclusive licensee, *Dubilier Condenser Corporation*.

Therefore enter their disclaimer as follows:

(1) To any "source of alternating current for supplying power to said amplifying means" as set forth in claim 1 except such as supplies raw alternating current to the cathode heating circuit or circuits of such amplifying means and rectified current to the plate circuit or circuits of such amplifying means; to any "plurality of means in circuit with said amplifying means for eliminating the hum of said alternating current in said apparatus" except such means as comprises: (*a*) a connection from the grid of the amplifying means to the cathode thereof at a point not subjected to the influence of variations of the cathode heating current; (*b*) elements connected between the stages of said amplifying means which prevent the passage of power supply frequencies; and (*c*) a resistor shunted by a condenser interposed in the circuit between the grid and cathode of the amplifying means where said condenser forms a low impedance path for both signal and power supply frequencies and wherein the voltage drop across said resistor provides a negative bias for the grid of the amplifying means.

(2) To any "source of alternating current for supplying power to said amplifying means" as set forth in claim 2 except such as supplies raw alternating current to the cathode heating circuit or circuits and rectified current to the plate circuit or circuits; to any "means connected to said amplifying and rectifying means for eliminating the hum of said alternating current in said apparatus" except as comprises: (*a*) a connection from the grid of the amplifying means to the cathode thereof at a point not subjected to the influence of variations of cathode heating current; (*b*) elements connected between the stages of said amplifying means and between said amplifying and rectifying means which prevent the passage of power supply frequencies; and (*c*) a resistor shunted by a condenser interposed between the grid and the cathode of the amplifying means, where said condenser forms a low impedance path for both signal and power supply frequencies and wherein the voltage drop across said resistor provides a negative bias for the grid of the amplifying means.

(3) To any "source of alternating current for supplying power to said amplifying means" as set forth in claim 3 except such as supplies raw alternating current to the cathode heating circuit or circuits and rectified current to the plate circuit or circuits of such amplifying means; to any "separate means connected to each of said amplifying and rectifying means for eliminating the hum of said alternating current" except as comprises: (*a*) connecting the grid of the amplifying means to the cathode thereof at a point not subjected to the influence of variations of the cathode heating current; and (*b*) elements connected between the "means for amplifying said signal energy at radio frequencies" and the "means for rectifying said energy" which prevent the passage of power supply frequencies.

(4) To any "source of alternating current for supplying power to said amplifying means" as set forth in claim 4 except such as supplies raw alternating current to the cathode heating circuit or circuits of such amplifying means and rectified current to the plate circuit or circuits of such amplifying means; to any "means connected to each of said amplifying, rectifying, and reproducing means for eliminating the hum of the alternating current" except such as comprises: (*a*) connecting the grid of the amplifying means to the cathode thereof at a point not subjected to the influence of variations of the cathode heating current, and (*b*) elements connected between stages of the amplifying means and between the amplifying means and the rectifying means which prevent the passage of power supply frequencies.

(7) To any "means in different parts of said circuits for eliminating the hum of the alternating current" as set forth in claim 7 except such as comprises: (*a*) connecting the grids of said amplifying means to the cathodes thereof at a point not subjected to the influence of variations of the cathode heating current; (*b*) elements interconnecting the stages of the "means for amplifying said energy at radio frequencies" and elements interconnecting the "means for amplifying said energy at radio frequencies" with the "means for rectifying said energy" which prevent the passage of alternating current hum; and (*c*) such means as a resistor shunted by a condenser connected in a circuit between the grid and cathode of the "means for amplifying said energy at radio frequencies" where the said condenser forms a low impedance path for both signal and power supply frequencies.

(13) To any "means for supplying the rectified energy to circuits of said vacuum tube amplifiers" as set forth in claim 13, except such as supplies such rectified energy to the plate circuits of said vacuum tube amplifiers and also supplies raw alternating current to the cathode heating circuit or circuits of said amplifiers; to any "means connected in each of the circuits of said amplifiers, detector and reproducer for eliminating the hum of said alternating current" except such as comprises: (*a*) connecting the grids of the amplifiers to the cathodes thereof at a point not subjected to the influence of variations of the cathode heating current; (*b*) elements interconnecting the stages of said radio frequency vacuum tube amplifier and interconnecting the output of said radio frequency vacuum tube amplifier with the detector which prevent the passage of power supply frequencies; and (*c*) a resistor shunted by a condenser and connected in the circuit between the grid and cathode of each of said amplifiers, where the said condenser forms a low impedance path for both signal and power supply frequencies.

(14) To any "means in each of said circuits for eliminating the hum" as set forth in claim 14, except as comprises: (*a*) connecting the grids of vacuum tubes to the cathodes thereof at a point not subjected to the influence of variations of the cathode heating current, and (*b*) interconnecting the plurality of vacuum tubes which amplify the signal energy at radio frequencies through elements which prevent the passage of power supply frequencies.

(15) To any "vacuum tubes" as set forth in claim 15 except vacuum tubes which have the grid electrodes thereof connected with the cathodes thereof at a point not subjected to the influence of variations of the cathode heating current; and to any "circuits interconnecting said electrodes and said detector" as specified in said claim except such circuits as include an inductively coupled radio frequency transformer.

(16) To any "source of alternating current for supplying power to said amplifying means" as set forth in claim 16 except such as supplies raw alternating current to the cathode heating circuit or circuits and rectified current to the plate circuit or circuits; to any "means connected in circuit with said rectifying means for smoothing out the rectified current and supplying power to said amplifying means" except such as also prevents distortion of the signal current.

(18) To any "source of alternating current for supplying power to said circuits" as set forth in claim 18 except such as supplies raw alternating current to the cathode heating circuit and rectified current to the plate circuit or circuits of the vacuum tubes; to any "means connected in circuit with said grid and plate electrodes for eliminating the hum" except such as comprises: (*a*) connecting the grids of the vacuum tubes to the cathode thereof at a point not subjected to the influence of variations of the cathode heating current, and (*b*) interposing filter elements in the plate circuit to reduce fluctuation in power supply frequencies; and to any "circuits interconnecting said electrodes" except as include a radio frequency transformer.

(19) To any "source of alternating current" as set forth in claim 19 except as supplies raw alternating current to the cathode heating circuit or circuits of said vacuum tubes; and to any "circuits interconnecting said electrodes" except as include elements which prevent the passage of [illegible]

of the amplifying means to the cathode thereof at a point not subjected to the influence of variations of the cathode heating current, and (*b*) elements connected between stages of the amplifying means and between the amplifying means and the rectifying means which prevent the passage of power supply frequencies.

(7) To any "means in different parts of said circuits for eliminating the hum of the alternating current" as set forth in claim 7 except such as comprises: (*a*) connecting the grids of said amplifying means to the cathodes thereof at a point not subjected to the influence of variations of the cathode heating current; (*b*) elements interconnecting the stages of the "means for amplifying said energy at radio frequencies" and elements interconnecting the "means for amplifying said energy at radio frequencies" with the "means for rectifying said energy" which prevent the passage of alternating current hum; and (*c*) such means as a resistor shunted by a condenser connected in a circuit between the grid and cathode of the "means for amplifying said energy at radio frequencies" where the said condenser forms a low impedance path for both signal and power supply frequencies.

(13) To any "means for supplying the rectified energy to circuits of said vacuum tube amplifiers" as set forth in claim 13, except such as supplies such rectified energy to the plate circuits of said vacuum tube amplifiers and also supplies raw alternating current to the cathode heating circuit or circuits of said amplifiers; to any "means connected in each of the circuits of said amplifiers, detector and reproducer for eliminating the hum of said alternating current" except such as comprises: (*a*) connecting the grids of the amplifiers to the cathodes thereof at a point not subjected to the influence of variations of the cathode heating current; (*b*) elements interconnecting the stages of said radio frequency vacuum tube amplifier and interconnecting the output of said radio frequency vacuum tube amplifier with the detector which prevent the passage of power supply frequencies; and (*c*) a resistor shunted by a condenser and connected in the circuit between the grid and cathode of each of said amplifiers, where the said condenser forms a low impedance path for both signal and power supply frequencies.

(14) To any "means in each of said circuits for eliminating the hum" as set forth in claim 14, except as comprises: (*a*) connecting the grids of vacuum tubes to the cathodes thereof at a point not subjected to the influence of variations of the cathode heating current, and (*b*) interconnecting the plurality of vacuum tubes which amplify the signal energy at radio frequencies through elements which prevent the passage of power supply frequencies.

(15) To any "vacuum tubes" as set forth in claim 15 except vacuum tubes which have the grid electrodes thereof connected with the cathodes thereof at a point not subjected to the influence of variations of the cathode heating current; and to any "circuits interconnecting said electrodes and said detector" as specified in said claim except such circuits as include an inductively coupled radio frequency transformer.

(16) To any "source of alternating current for supplying power to said amplifying means" as set forth in claim 16 except such as supplies raw alternating current to the cathode heating circuit or circuits and rectified current to the plate circuit or circuits; to any "means connected in circuit with said rectifying means for smoothing out the rectified current and supplying power to said amplifying means" except such as also prevents distortion of the signal current.

(18) To any "source of alternating current for supplying power to said circuits" as set forth in claim 18 except such as supplies raw alternating current to the cathode heating circuit and rectified current to the plate circuit or circuits of the vacuum tubes; to any "means connected in circuit with said grid and plate electrodes for eliminating the hum" except such as comprises: (*a*) connecting the grids of the vacuum tubes to the cathode thereof at a point not subjected to the influence of variations of the cathode heating current, and (*b*) interposing filter elements in the plate circuit to reduce fluctuation in power supply frequencies; and to any "circuits interconnecting said electrodes" except as include a radio frequency transformer.

(19) To any "source of alternating current" as set forth in claim 19 except as supplies raw alternating current to the cathode heating circuit or circuits of said vacuum tubes; and to any "circuits interconnecting said electrodes" except as include elements which prevent the passage of power supply frequencies.

(20) To any "source of alternating current for supplying power to said amplifying means" as set forth in claim 20 except as supplies raw alternating current to the cathode heating circuit or circuits of said amplifying means and rectified current to the plate circuit or circuits of said amplifying means.

(21) To any "source of alternating current for supplying power to said tubes" as set forth in claim 21 except such as supplies raw alternating current to the cathode heating circuit or circuits and rectified current to the plate circuit or circuits of said tubes.

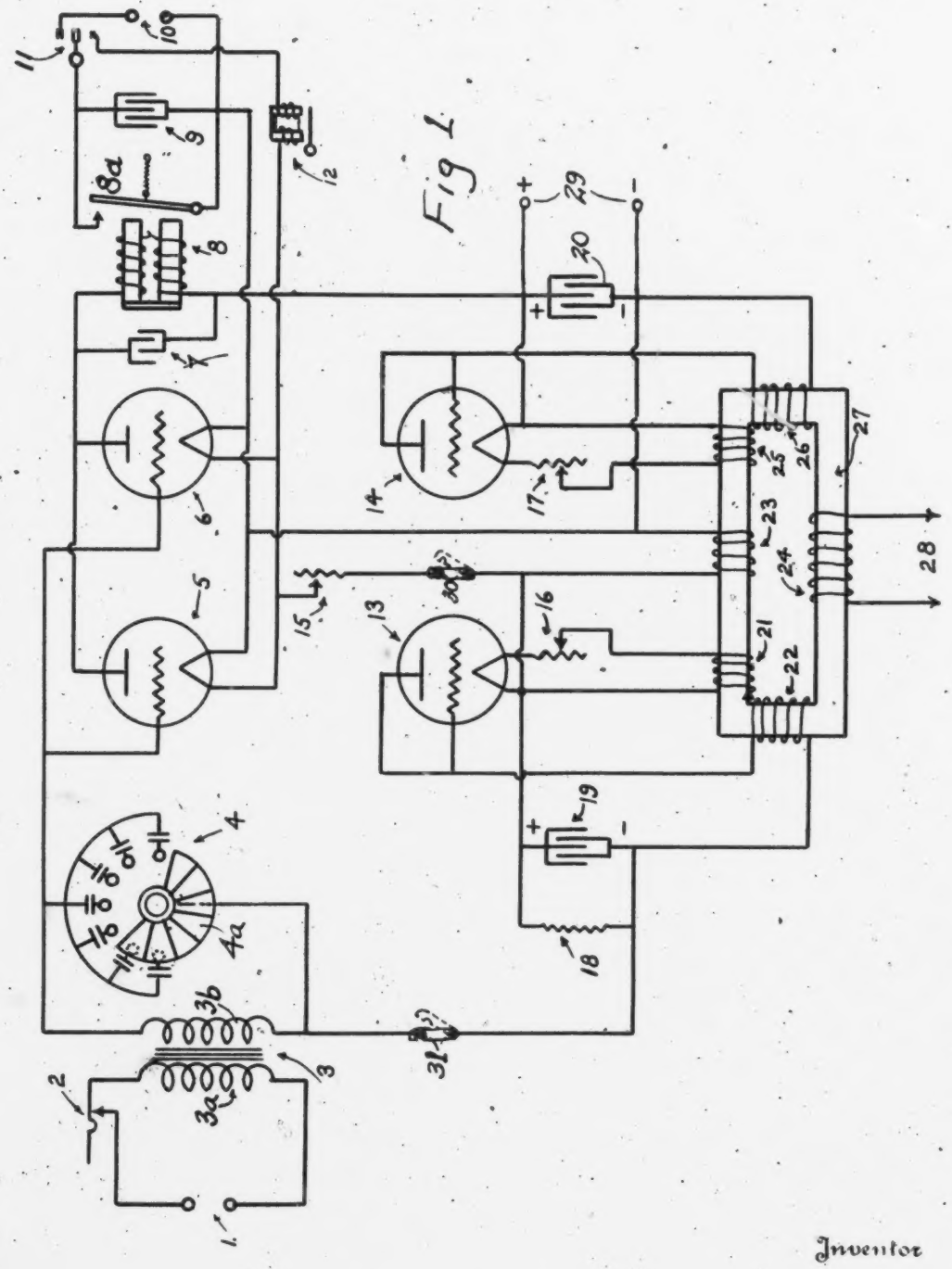
PATENT 1,635,117, TO FRANCIS W. DUNMORE.
Referred to in Paragraph 10 of the Bill of Complaint.

449 July 5, 1927. 1,635,117

F. W. DUNMORE

SIGNAL RECEIVING SYSTEM

Filed Feb. 27, 1922 3 Sheets-Sheet 1



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SIGNAL RECEIVING SYSTEM

Filed Feb. 27, 1922 3 Sheets-Sheet 2

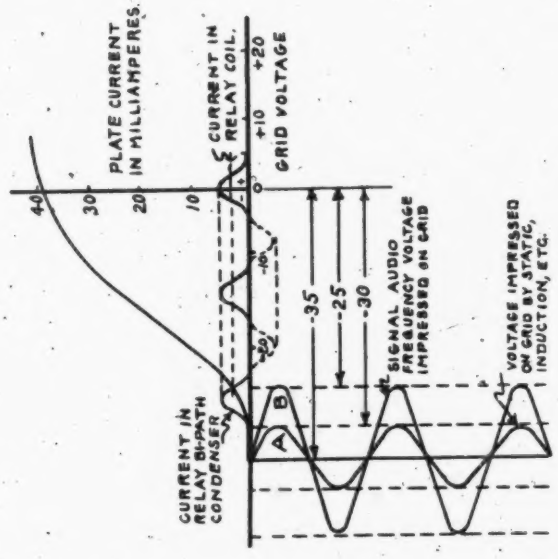

Fig 3

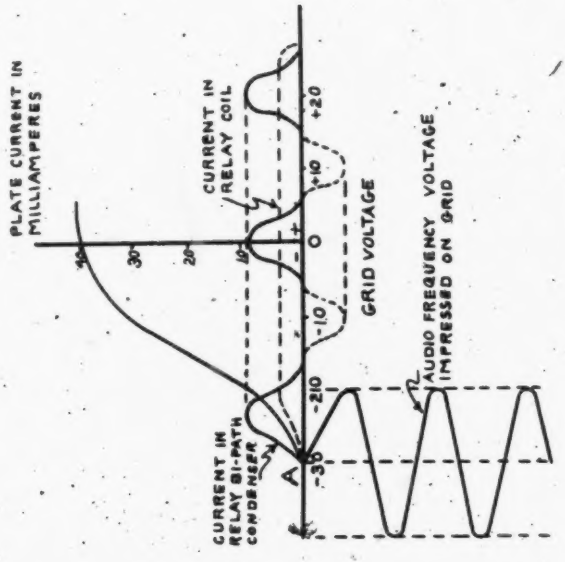

Fig 2.

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452 July 5, 1927. 1,635,117

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SIGNAL RECEIVING SYSTEM

Filed Feb. 27. 1922 3 Sheets-Sheet 3

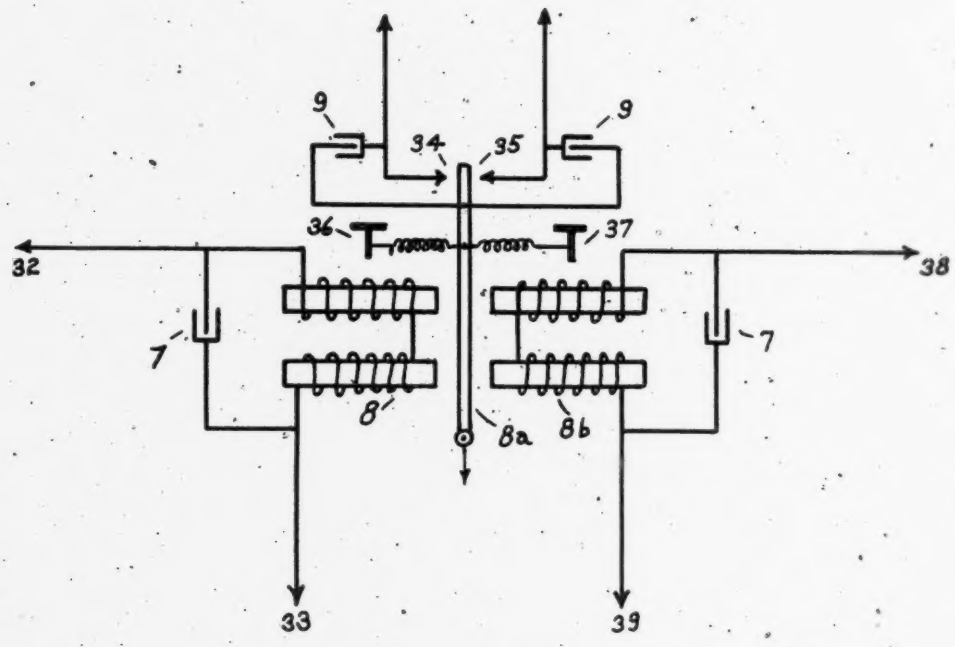

Fig. 4.

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UNITED STATES PATENT OFFICE.

FRANCIS W. DUNMORE, OF WASHINGTON, DISTRICT OF COLUMBIA.

SIGNAL-RECEIVING SYSTEM.

Application filed February 27, 1922. Serial No. 539,591.

My invention relates broadly to audio frequency signal receiving systems and more particularly to relays for operation at a receiving station for the local or remote control of auxiliary apparatus.

My invention has for its principal object the provision of relays selectively operative upon the reception of signals of slightly separated tone frequency and particularly adaptable for reception of signals in wire wireless and radio telegraph systems.

The object of my invention is to provide a circuit arrangement for audio frequency signal receiving relays.

A further object of the invention is to provide a relay which may be constructed as a portable unit and operated from any alternating current source of power circuit supply, such as the residence lighting circuit usually employing an alternating current of 60 cycles frequency at 110 volts, for the positive closing of a circuit at a signal receiving station for the control of any desired local or remote apparatus.

A further object of the invention is to provide a relay with thermionic vacuum tubes with input and output circuit characteristics whereby positive closing of a mechanical relay may be secured in the output circuit of the apparatus upon control of the input circuit from a relatively feeble audio frequency impulse.

A still further object of the invention is to provide a thermionic vacuum tube relay apparatus highly selective in its operation dependent upon the tone frequency of the incoming signals.

Another object of the invention is to provide a complete relay including thermionic vacuum tube circuits with power connections for adaptation to any suitable external source of power, such as primary or secondary batteries or suitable lighting power circuits, with means for adjusting the input and output circuits of the thermionic vacuum tube circuits for the positive reception of signals of different audio tone characteristics.

Another object of the invention is to provide a relay circuit with minimum responsiveness to static and local disturbances not desired to be received.

In constructing the relay of the present invention, for operation in radio telegraph receiving systems, or any other system involving a tone frequency reception, the following characteristics have been secured as necessary requirements for a satisfactory relay to be employed in radio or wire reception as a positive circuit closer for operation of any variety of apparatus at a receiver, such as dynamic control circuits, automatic printing equipment, tape recorders or other recorder circuits for audible reception: (1) The relay must be of simple construction with few adjustments; (2) it must be easy to adjust and capable of being put into operation quickly; (3) it must be selective and as free from static and such disturbances as possible; (4) it must be capable of operating at a speed of at least 50 words a minute; (5) it must respond to weak signals; (6) it must be of rugged design, durable and capable of maintaining its adjustments; and (7) it must be portable.

My invention will be more clearly understood by reference to the following specification and the accompanying drawings, in which: Fig. 1 is a schematic wiring diagram of the relay showing the input circuit and terminals for connection of the relay to an external power supply and audio frequency signal source; Fig. 2 shows the characteristic curves for the thermionic vacuum tubes employed in the relay; Fig. 3 shows the characteristic curves illustrating a method of eliminating static, induction, etc, when such interference is not stronger than the signal; and Fig. 4 is a schematic diagram of an application of the relay.

It will be understood that the principles of my invention may be embodied in various forms and that details are not material. The present embodiment of the invention, therefore, is to be considered as merely indicative. The form illustrated in the drawing and hereinafter described in detail has been found to be one of the practical embodiments and capable of efficient operation and practical in construction for use at a radio and wire receiver for operation of signal recorders. The relay is also applicable to many other uses such as multiplex line wire telegraphy, radiodynamic control and wire wireless operation.

The multiplex operation of the relay with wire wireless is made possible by the audio tuning features of this relay, as the combination of numerous radio frequencies with the various different heterodyne notes thus obtainable provides a wide range for the selective application of the relay for wire

wireless Morse telegraphy. Numerous telephone or telegraph lines may be fed from one source of radio frequency, each line having a power amplifier modulated at one or more audio frequencies each of said frequencies selectively operating the present type relay.

The relay comprises broadly an input circuit which is energized from any source of audio frequency current, such as secured after the process of rectification at a wire or radio receiver, or as is secured in multiplex carrier wave telegraphy, or that produced by the heterodyne of two radio frequencies. The input circuit of the relay comprises an audio frequency input transformer the secondary terminals of which are connected to the grids and filaments of one or more receiving tubes which are operated in parallel. This input transformer secondary circuit is made adjustable for desired signals of different tone characteristics by means of a variable condenser shunted across the terminals thereof. The plates of the receiving tube are parallel connected and are included in an external output circuit energized from rectified energy taken from a winding upon an alternating current transformer having its primary winding energized from a source of supply such as the 110 volt 60 cycle residence lighting circuit or from any source of DC supply of from 160 to 200 volts. The current for operating the tube filaments is also obtained from a proportionate winding upon the core of this transformer or from a DC source of supply of suitable voltage. The grid circuit voltage for the bias upon the grids of the vacuum tubes is obtained by rectification of energy supplied from another proportionate winding upon the core of this transformer or from a suitable source of DC voltage.

The rectifiers employed may be two electrode tubes having the filaments thereof heated from current derived from proportionate windings upon the core of this transformer. In the output circuit of the amplifier tubes a mechanical relay is arranged, having its winding proportioned with the characteristics of the output circuit and shunted by an audio frequency bi-path condenser. This mechanical relay operates to close a positive electrical circuit which may be employed for the local or remote control of any variety of instruments.

Referring more particularly to Fig. 1 of the drawings, reference character 1 indicates the input terminals for the relay, 2 represents a telephone socket in which may be inserted a pair of telephones by which the operator may check up the operation of the relay or listen to the received signals in the usual way without employing the relay recorder. 3 indicates an audio frequency transformer, the primary winding 3^a of which forms a part of the input circuit of the relay and the secondary winding 3^b of which connects to the input circuit of the tubes 5 and 6. Bridged across the secondary winding 3^b is an audio frequency tuning condenser 4 variable by steps upon the adjustment of switch 4^a. This condenser may also be of the continuously variable air condenser type. The grids of the tubes 5 and 6 are biased from energy derived from proportionate windings upon transformer 27, the primary winding 24 of which connects through terminals 28 with a source of alternating current supply, such as the 110 bolt 60 cycle AC residence lighting current. The transformer 27 contains six windings, including the primary energizing winding 24. A proportionate secondary winding 23 supplies current to the filaments of the power tubes 5 and 6 through rheostat 15. The winding 26 supplies the high voltage for the plate circuit of the tubes 5 and 6. The winding 22 supplies the grid voltage for the tubes 5 and 6.

Tubes 13 and 14 are employed as two electrode valves and are used as half wave rectifiers, tube 14 supplying the plate voltage with energy derived from winding 26, and tube 13 supplying the grid voltage with energy derived from winding 22. In these tubes 13 and 14 the grids and plates are represented as electrically connected, forming two electrode valves. The rectified alternating current is smoothed out for the grid voltage by condenser 19. The rectified alternating current for the plate circuit is smoothed out by condenser 20. These condensers are connected respectively across the output terminals of the rectifiers. The filaments of tubes 13 and 14 are heated from energy derived from proportionate windings 21 and 25, and the temperature controlled by rheostats 16 and 17 respectively. A high resistance leak 18 of a value from 40,000 to 100,000 ohms is shunted across the output circuit of the rectifier tube 13 supplying voltage to the grids of tubes 5 and 6, as otherwise the grids of tubes 5 and 6 are insulated from the filaments of the tubes by the rectifier tube 13. By means of the filament rheostats 16 and 17 the grid and plate voltages respectively may be varied over any ranges desirable for the most efficient operation of the recorder.

Binding posts 29, 30 and 31 are provided on the relay for connection to primary or secondary batteries where the alternating current supply is not available. Binding posts 30 are normally shunted as indicated, but this shunt may be disconnected and connections made with an "A" battery of suitable voltage for filament lighting. Binding posts 31 are normally shunted when power is derived from the AC supply but in the absence of such supply are disconnected and

connections made with a "C" battery for biasing the grids of tubes 5 and 6. This battery should be preferably variable from 20 to 80 volts in steps of 10 volts. Binding posts 29 are provided for the connection of a high voltage "B" battery of from 160 to 250 volts for the plate circuit supply in the absence of the alternating current power source.

In the plate circuit of the tubes 5 and 6 the mechanical relay 8 is included. The windings of the relay are proportioned to the internal resistance of tubes 5 and 6 to secure high sensitivity.

A suitable condenser 7 is shunted across the relay winding 8 as a bi-path for the audio frequency plate currents which in turn cause DC plate current fluctuations at the keying frequency, which variations pass through the winding 8 and operate the relay armature 8^a. The relay is provided with armature 8^a with the circuit closer contact shunted by condenser 9 for absorption of the make and break discharge. The relay may be of the mechanically tuned type in which case condenser 7 would be omitted. The speed of operation is also dependent upon the type of mechanical relay employed.

The circuit closer 8^a is arranged in the circuit with switch 11 adapted to be thrown to different contact points to connect the circuit direct to output terminals 10. which may in turn be connected to any local or remote apparatus to be operated by the relay, or to connect a test buzzer 12, in circuit with a source of energy from winding 23, which also supplies the filament lighting current for tubes 5 and 6. The buzzer 12 may be of the synchronous type without the vibrator intermittent contact. Any variety of instruments may be connected to the terminals 10, such as a tape or drum type recorder, a printer recorder or dynamic control apparatus.

The principle of operation of the relay will be understood by reference to Fig. 2, which shows a set of curves characteristic of the relay for remote control by radio. By means of the variable biasing potential of the grids of the tubes 5 and 6, obtained by variation of rheostat 16 of rectifier 13, the grid voltage is adjusted to approximately 30 volts, at which value the plate current is zero as indicated at A, Fig. 2.

The incoming audio frequency voltage impressed on the grid varies the grid potential, for example, from —30 to —20 volts. the 10 volts decrease from —30 to —20 causes an increase, for example from 0 to 10 milliamperes in plate current while the increase from —30 to —40 volts is not effective in causing a plate current to flow due to the fact that —30 volts is already sufficient to reduce the plate current to zero. The result will be a pulsating direct current of 10 milliamperes, maximum amplitude in the plate circuit. This current flowing through the plate circuit and condenser 7 causes an increase in the plate current at the keying frequency, which change, passing through the relay coil will pull the relay armature over, making contact at 8^a which contact may control any mechanism desired. With the "C" battery grid voltage adjusted for maximum sensitivity, it was found that static, induction, etc., operated the relay. When these disturbances are not as strong as the signal, their effect on the relay may be overcome as shown at Fig. 3. For example, the "C" battery is shown increased to —35 volts, the critical value for maximum sensitivity being —30 volts. The disturbance due to strays, etc. merely reduces the "C" battery voltage to —30 which is not sufficient to cause plate current to flow. However, the signal, being of greater intensity than the strays reduces the voltage to —25, which causes a plate current of 5 milliamperes. It will be seen therefore that all disturbing effects, if of less intensity than the signal, do not affect the relay.

It has been found during the development of this relay that the rectified audio-frequency current in the plate circuit caused the relay armature to vibrate rapidly in the closed position, thus causing a poor contact. This was overcome completely, however by the addition of a one-microfarad condenser 7 across the relay coils. This served the purpose of an audio frequency bi-path for the highly inductive winding of the relay, thus greatly decreasing the resistance of the circuit. The change of plate current due to this audio frequency caused a second change which occurred at the keying frequency. This latter change passes readily through the relay coils and exerts a strong steady pull on the relay armature without the least chattering.

It has also been found that the variable condenser across the secondary 3^b of the input audio transformer made possible audio tuning, which increased the selectivity and sensitivity considerably. This tuning was very sharp, and it was found that European stations could be made to operate the relay while a high power station here in the United States would fail to operate it, although the high power station was coming in on the same wave length and slightly stronger. This was made possible by adjusting the heterodyne note of the European station to a frequency different from that of the local station and then tuning the secondary of the audio-transformer to that frequency. The variable condenser may be replaced by a fixed condenser and the audio tuning accomplished by adjusting the heterodyne note to the resonant frequency. By means of this audio tuning one of three sta-

tions transmitting simultaneously have been selected and caused to operate the relay though all were of equal intensity. By the use of two recorders operated in series, each working one pen of a double ink register, it was possible to make a simultaneous record of signals made by the spacer wave and sending wave from the U. S. naval high power radio station at Annapolis, Md., at a distant receiving station.

Tests showed that with a signal strength sufficient to produce a plate current of 10 milliamperes, the relay could be operated at a speed of 48 contacts per second, the contact being sufficient to operate a buzzer. With three milliamperes in the plate circuit, a speed of 27 contacts per second was obtained. With one milliampere a speed of 19 per second. In each case the relay armature spring tension was adjusted for the best operation.

The relay is adapted to have all the parts mounted within a readily portable cabinet, and provided with plug connections for direct connection of the apparatus to the lighting circuit power supply, and in the absence of such power binding posts for "A", "B" and "C" batteries are provided so that the relay may be operated in places where the AC supply is not available.

The apparatus may be operated in a combination system as shown in Fig. 4, wherein two different mechanical relays 8 and 8^b of similar construction are arranged to actuate a common armature 8^a. The armature may be mounted to swing in opposite directions in accordance with the pull of the diametrically opposed mechanical relay magnets 8 and 8^b, connected in the output circuits of two different vacuum tube relay equipments. The terminals 32 and 33 go to said output circuit of one relay and the terminals 38 and 39 go to the output circuit of another similar relay. The terminals 32 and 38 go to the plates of the relay vacuum tubes and 33 and 39 to the source of plate voltage.

Contacts closed by the armature at 34 and 35 in its movement to either side from its normal midway position permits the closing of a variety of work circuits. Adjustment springs at 36 and 37 hold the armature normally in the midway position between the two contacts 34 and 35.

This method may be used to render a crossed coil radio direction finder a direct reading and self setting device similar to a magnetic compass or it may be used to hold a moving object on a given course when used in conjuction with an equi-signal crossed coil, directional transmitter.

Having thus described my invention, what I claim and desire to secure by Letters Patent of the United States is as follows:

1. The combination in a signal receiving system of a source of audio frequency signals, a plurality of thermionic vacuum tubes having grid, filament and plate electrodes, an audio frequency input circuit including each of said grid electrodes and an output circuit including each of said plate electrodes, a source of alternating current power supply, means associated with said alternating current power supply for impressing a negative potential on said grid electrodes, and a positive potential on said plate electrodes and energizing said filament electrodes and a relay in said output circuit and arranged to respond to said source of audio frequency signals.

2. The combination in a signal receiving system of a source of audio frequency signals, a plurality of thermionic vacuum tubes having grid, filament and plate electrodes, connections between the respective electrodes of said tubes, an audio frequency input circuit, an output circuit, means for selectively tuning said input circuit, a source of alternating current power supply, means for energizing said filaments, a rectifier adapted to supply a negative potential to said grid electrodes from said source of alternating current, a rectifier adapted to apply a positive potential to the plate electrodes in said output circuit from said source of alternating current, and a mechanical relay in said output circuit actuated by said audio frequency signals.

3. The combination in a signal receiving system of a source of audio frequency signals, a thermionic vacuum tube having a grid, filament and plate electrode, an audio frequency input circuit, an output circuit, a source of alternating current power supply, means for energizing said filament, a rectifier adapted to supply a negative potential to the grid electrode in said input circuit, a condenser and a resistance parallelly connected across the output of said rectifier, a second rectifier adapted to apply a positive potential to the plate electrode of said output circuit from said source of alternating current, a condenser connected across the output of said rectifier and a mechanical relay in said output circuit actuated by said audio frequency signals.

4. The combination in a signal receiving system of a source of audio frequency signals, a plurality of thermionic vacuum tubes having grid, filament and plate electrodes, connections between the respective electrodes of said tubes, an audio frequency input circuit including said grid electrodes, an output circuit including said plate electrodes, means for selectively tuning said input circuit, a source of alternating current power supply, means for energizing said filaments, a rectifier adapted to supply a negative potential to said grid electrodes from said source of alternating current, means for smoothing out the energy delivered by said

rectifier, a second rectifier adapted to positively energize said plate electrodes from said source of alternating current, means for smoothing out the energy delivered to said output circuit and a mechanical relay in said output circuit actuated by the audio frequency signals selected by said input circuit.

5. The combination in a signal receiving system of a source of audio frequency signals, a plurality of thermionic vacuum tubes having grid, filament and plate electrodes, an audio frequency input circuit, means in said input circuit for discriminating against signals of undesired frequency and selectively receiving signals of a desired frequency, an output circuit, a source of alternating current power supply, means for energizing said filaments, rectifiers comprising valves containing heated and cold electrodes for negatively charging the grid electrodes and positively charging the plate electrodes of said input and output circuits from said source of alternating current, means for varying said energy, means for smoothing out the energy delivered by said rectifiers and a mechanical relay in said output circuit actuated by the audio frequency signals selected by said means in said input circuit.

6. The combination in a signal receiving system of a source of audio frequency signals, a plurality of thermionic vacuum tubes having grid, filament, and plate electrodes, an audio frequency input circuit, an output circuit, means for sharply tuning said input circuit to a selected audio note, a source of alternating current power supply, means for energizing said filaments, a two electrode rectifier adapted to supply a negative potential to the grid electrodes of said input circuit from said source of alternating current, means for smoothing out the energy delivered by said rectifier, a second two electrode rectifier adapted to positively charge the plate electrodes of said output circuit from said source of alternating current, means for smoothing out the energy delivered to said output circuit and a mechanical relay in said output circuit actuated by said audio frequency signals at the selected audio note distinguished by said input circuit.

7. The combination in a signal receiving system of a source of audio frequency signals, a plurality of thermionic vacuum tubes having grid, filament and plate electrodes, an audio frequency input circuit, an output circuit, means connected in shunt with said input circuit for sharply tuning said circuit to a selected tone frequency, a source of alternating current power supply, rectifiers comprising valves containing heated and cold electrodes for impressing negative and positive potentials on said grid and plate electrodes respectively in said input and output circuits from said source of alternating current, means for varying the temperature of said heated electrodes whereby to vary the potential impressed upon said grid and plate electrodes and a mechanical relay in said output circuit actuated by said audio frequency signals at the tone frequency selected by said input circuit.

8. The combination in a signal receiving system of a source of audio frequency signals, a thermionic vacuum tube having grid, filament and plate electrodes, a selectively tuned input circuit, an output circuit, a source of alternating current, a rectifier, means for impressing rectified energy on said grid electrode in said input circuit, a high resistance leak shunted across said rectifier and a mechanical relay in said output circuit actuated by said signals.

9. A signal receiving system comprising in combination an audio frequency amplifier including an electron tube having grid, filament and plate electrodes, an input circuit interlinking said grid and filament electrodes, an output circuit interlinking said plate and filament electrodes, a source of alternating current, means for rectifying said current, means for supplying a negative potential to the grid electrode of said electron tube from said source of alternating current, and means for supplying a positive potential to said plate electrode from said source of alternating current, whereby said audio frequency amplifier operates to amplify signaling energy without interference from said source of alternating current.

10. In a signal receiving system the combination of a source of audio frequency signals, an electron tube having grid, filament and plate electrodes, an input circuit interconnecting said grid and filament electrodes, an output circuit interconnecting said plate and filament electrodes, a source of alternating current, independent rectifiers for rectifying said alternating current, connections between one of said rectifiers with said input circuit for impressing a negative potential on said grid electrode, connections between said other rectifier with said output circuit for impressing a positive potential on said plate electrode, and a responsive device connected in the output circuit for actuation by amplified signaling energy.

11. In a direct current supply source for vacuum tubes and the like, the combination of a source of power adapted to be energized by alternating current or the like, means for converting such current into current of constant duration, means for smoothing out fluctuations in such current comprising a filter and a resistance connected across the output side of said filter and output terminals connected at opposite ter-

minals of said resistance, said resistance being of such value that the current flowing therethrough is relatively large with respect to the current supplied to the load.

12. A method of energizing thermionic vacuum tubes or the like from a source of alternating current, which comprises rectifying such alternating current to produce fluctuating direct current, filtering out fluctuations from such fluctuating current, passing such filtered currents through a resistance to produce a voltage drop therethrough and impressing the desired portion of such voltage drop upon said thermionic tube.

FRANCIS W. DUNMORE.

DISCLAIMER

1,635,117.—*Francis W. Dunmore*, Washington, D.C. SIGNAL-RECEIVING SYSTEM. Patent dated July 5, 1927. Disclaimer filed July 8, 1933, by the patentee and the exclusive licensee, *Dubilier Condenser Corporation*.

Hereby enter their disclaimer to:

(1) Any "source of alternating current power supply" in claim 1 except such as delivers rectified alternating current to said grid electrodes and raw alternating current to said filament electrodes; to any "means associated with said alternating current power supply for impressing a negative potential on said grid electrodes" in said claim 1, except such means as comprise a resistance in series with said grid electrodes shunted by a condenser; to any "means for energizing said filaments" as specified in claims 2, 3, 4, 5, and 6, except such means as supply raw alternating current to said filaments; and to any "rectifier adapted to supply a negative potential to said grid electrodes" as specified in claims 2, 4, 5, and 6 except such as supply such negative grid biasing potential by means of a bias determining resistance in series with the grid electrodes and connected to the respective cathodes of the amplifying tubes and shunted by a condenser of low impedance to power supply frequencies.

(2) Any "filament electrodes" specified in claim 9 except such as are energized by raw alternating current; and any "means for supplying a negative potential to the grid electrode of said electron tube from said source of alternating current" as specified in claim 9 except such means as comprise a bias determining resistance connected in a series path between the grid and filament electrodes and shunted by a condenser of low impedance to power supply frequencies.

(3) Any "source of power adapted to be energized by alternating current or the like" as specified in claim 11, except such as supplies raw alternating current to the cathode heating circuits of such tubes and rectified current to the grid circuits of such tubes; and to any "output terminals connected at opposite terminals of said resistance" as specified in said claim, except such as are also connected to the grid and cathode of the vacuum tube.

(4) Any "method of energizing thermionic vacuum tubes or the like from a source of alternating current" as specified in claim 12, except such as supplies raw alternating current to the cathode heating circuit of such tubes and rectified current to the grid circuit of such tubes; and to "impressing the desired portion of such voltage drop upon said thermionic tube" except to impressing the desired portion of the voltage drop upon the grid-cathode circuit of said thermionic tube.

[*Official Gazette August 1, 1933.*]

[fols. 24 & 25] EXHIBIT "A"

Attached to Plaintiffs' Affidavit in Opposition to the Motion to Dismiss

In the United States Patent Office,

Before the Board of Appeals

In Re Interferences:

Interference No. 51,204

LOWELL & DUNMORE

v.

BLATTERMAN

Interference No. 51,702

PUPIN

v.

LOWELL & DUNMORE

v.

BLATTERMAN

Interference No. 53,154

PUPIN

v.

DUNCAN

v.

LOWELL & DUNMORE

v.

BLATTERMAN

Interference No. 53,155

DUNCAN

v.

LOWELL & DUNMORE

Decisions Affirming Examiner of Interferences and Awarding Priority to Lowell & Dunmore

John B. Brady, Attorney for Lowell and Dunmore.

[fol. 26] U. S. Patent Office, Board of Appeals. July 25, 1931. Mailed.

1—6689-C

Appeals Nos. 4820-21-22

Hearing: May 12, 1931

OVT.

In the United States Patent Office,

Before the Board of Appeals

PUPIN

v.

DUNCAN

v.

LOWELL AND DUNMORE

v.

BLATTERMAN

Patent Interference No. 53,154 between an application of Michael I. Pupin filed February 4, 1924, Serial No. 690,586; an application of Robert D. Duncan, Jr., filed October 20, 1923, Serial No. 669,662; the patent granted Percival D. Lowell and Francis W. Dunmore on May 15, 1923, No. 1,455,141, on an application filed March 27, 1922, Serial No. 547,111; and an application of Albert S. Blatterman filed March 10, 1922, Serial No. 542,525. Radio Receiving Apparatus.

Mr. O. H. Eschholz and Messrs. F. W. Lyle & W. H. Whitten for Pupin.

Mr. Philip S. McLean for Duncan.

Mr. John B. Brady and Mr. John Boyle, Jr. for Lowell and Dunmore.

Mr. David P. Wolhaupter for Blatterman.

[fol. 27] This case comes up on appeal from the decision of the Examiner of Interferences awarding priority of invention of the subject matter in issue to the party Lowell and Dunmore. Each of the other three parties, Pupin, Duncan and Blatterman, has appealed.

The issue is stated in a single count which reads as follows:

In an apparatus for the reception of radio signals the combination of a source of signal energy, means for amplifying said signals, means for rectifying said signals, a source of alternating current for supplying power to said amplifying means, and means connected to said amplifying and rectifying means for eliminating the hum of said alternating current in said apparatus.

The count is a copy of claim 2 of the Lowell and Dunmore patent No. 1,455,141, granted May 15, 1923, on an application filed March 27, 1922. Neither Pupin nor Duncan filed his application involved herein until after the issuance of said patent and consequently each is under the burden of proving his case beyond a reasonable doubt. Blatterman filed on March 10, 1922, and is the senior party in this proceeding.

The invention relates to apparatus for receiving radio signals in which a source of alternating current is used for supplying power to the means for amplifying the signals. The count includes means for rectifying the signals and means connected to the amplifying and rectifying means for eliminating the hum of said alternating current in the apparatus.

The juniormost party, Pupin, is relying on the filing date, December 31, 1915, of his application Serial No. 69,566, which matured into patent No. 1,571,458, on February 2, 1926, for constructive reduction to practice. The testimony submitted by him is solely for the purpose of aiding in the interpretation of the language used in his earlier application. Each of the other three parties has taken testimony relating to priority of invention.

[fol. 28] Considering first the case of Pupin, it is evident he can prevail only if the invention defined in the count is fairly disclosed in his earlier application. The filing date of that application is prior to any date alleged by any of the other parties.

The 1915 Pupin application drawing shows a direct current generator provided with two commutators, one of which supplies a line with a small current at a relatively high voltage and the other of which supplies another line with a larger current at a relatively low voltage. A plurality of filtering units is provided in each line for smoothing out the fluctuations. The specification states that the

pilot conductor, which is the line supplying the larger current, is well adapted to replace the storage batteries used to heat the filaments in vacuum tubes employed in wireless telegraphy and that the artificial cable supplying the small current at higher voltage is likewise adapted to replace the electric batteries used in wireless telegraphy for charging electrodes in vacuum tubes or for maintaining a small current through such tubes. It also states:

"A machine like that shown in the drawing, having two commutators and two associated pilot conductors, is well adapted to replace both of the batteries which are used today for heating the filaments and for exciting the vacuum tube relays and amplifiers in wireless wave transmission systems."

It also, on page 6, suggests the substitution of an alternating current generator and a mercury rectifier for the direct current generator.

Pupin, in his brief, advances several reasons in support of his contention that the disclosure in his earlier application supports the count. He states that apparatus used in wireless telegraphy includes that at the receiving station as well as that at the transmitting station, and that likewise the expression "transmission systems" in the sentence quoted above should be interpreted as applicable to receiving apparatus. His Exhibits Nos. 2 and 3 were introduced in evidence to show that in the patented art and technical [fol. 29] publications existing in 1915 this expression is sometimes used in this sense. He also urges that in 1915 vacuum tubes were more commonly employed in receiving apparatus than in transmitting apparatus and also that separate batteries were more frequently used in the former. He further urges that there was a real necessity of removing hum in the receiving apparatus while the necessity did not exist in connection with the transmitting apparatus. In view of all these considerations and the fact that in the sentence quoted above reference is made to relays as well as to amplifiers, Pupin insists that the disclosure in the earlier application would naturally be interpreted by those skilled in the art as describing receiving apparatus constructed and arranged in the manner defined in the count.

All of Pupin's arguments have been carefully considered, but we are persuaded in view of the various features of

uncertainty in the earlier application disclosure, that said application should not be held as definitely pointing out the invention in issue. No mention is made of receiving apparatus as such and it is questionable that the expression "transmission systems" was intended to include receiving apparatus. The expression "vacuum tube relays" is not clearly distinguished from vacuum tubes when used as amplifiers, and if intended to be so distinguished it fails to definitely designate a rectifier of receiving apparatus.

The count is clearly limited to receiving apparatus having means for rectifying the signals and is further limited to a specific arrangement of parts in which the hum eliminating means is connected not only to the amplyfying means but also to the rectifying means. We accordingly hold with the examiner that Pupin is not the prior inventor of the subject matter in issue.

The proofs adduced by the party Duncan can be considered as overcoming the filing dates of the senior party Blatterman and the appellees Lowell and Dunmore, both in March, 1922, only under one or the other of the two following assumptions, first, that certain tests made by Duncan and his assistant, Isler, in 1921 amounted to a reduction to practice of the invention, and second, that Duncan [fol. 30] has established conception as early as 1921 followed by due diligence at the time his opponents entered the field and from then until Duncan reduced to practice.

The tests referred to are alleged to have been made of circuit arrangements corresponding to those shown in Duncan's Exhibit No. 15, which is a sketch made by Duncan while testifying. Duncan and Isler fix the time of these tests as prior to May 7, 1921, by reference to the fourth sheet of the reports forming Duncan's Exhibit No. 3. They state that the fourth paragraph on this sheet refers to said tests. This paragraph reads as follows:

"4. A few experiments were conducted with a view to operating the filaments of receiving tubes from alternating current. So far no entirely satisfactory results have been obtained, but a method has been worked out which it is believed with proper development will entirely eliminate the presence of the 60 cycle ripple in the telephone receivers."

Notwithstanding the testimony of Duncan and Isler as to the success of these tests, it seems to us that the tests did not amount to a reduction to practice of the apparatus tested. This record made at the time of the tests clearly indicate that the tests were not then regarded as being successful and that further development work would be necessary.

We believe that the circuit arrangement of Duncan's Exhibit No. 15 does not include a connection between the hum eliminating means and the detector, but such holding is not material to a proper determination of the case, for, if it be assumed that Duncan has established conception as early as May 7, 1921, it is clear from Duncan's testimony that he did nothing further with the invention in issue prior to the year 1923. In the meantime, during which Duncan was not exercising due diligence, both Lowell and Dunmore, and Blatterman constructively reduced the invention to practice by filing their applications involved herein.

We accordingly hold that Duncan is not entitled to the award of priority of invention in this proceeding.

[fol. 31] The examiner held that Lowell and Dunmore have established conception on December 8, 1921, and reduction to practice at least as early as January 20, 1922. It is believed their proofs, and particularly the exhibits and testimony designated in the examiner's decision, justify these holdings. We further note that the count is readable on the circuit dated December 10, 1921, on page 49 of Dunmore's note book (Lowell and Dunmore Exhibit No. 8) which fact further indicates that they had a complete conception of the invention in issue as early as that date.

The senior party Blatterman is relying on the test described on pages 21 and 22 of his note book introduced in evidence as his Exhibit A. A copy of the contents of this book is included in his Exhibit C, and Exhibit E is an enlargement of the circuit shown on page 21 of the note book. The entry is dated November 28, 1921, which is just ten days prior to the date accorded Lowell and Dunmore for conception.

The circuit includes three radio frequency amplifier tubes, a detector tube and two audio frequency amplifier tubes. The filaments and plate circuits of the detector and audio frequency amplifiers are supplied with direct current by batteries. A rectifier tube is used for rectification of

110 volt 60 cycle alternating current to supply the plate circuits of the radio frequency amplifiers. The filaments of this power rectifier and said amplifiers are heated by alternating current supplied by a stepdown transformer connected to the power circuit. Hum eliminating means are provided in the condenser C and in the 1000 ohm potentiometer which is connected across the filament terminals, and to the sliding element of which the return leads of the grids and plates are connected.

Neither of these hum eliminating means is connected to the means (detector) for rectifying the signals, as required by the count. Blatterman urges, however, that the third radio frequency transformer, the primary winding of which is in the output circuit of the third radio frequency amplifier tube and the secondary winding of which is in the input circuit of the detector tube, responds to the hum eliminating means defined in the count.

[fol. 32] This radio frequency transformer was in the SCR122 receiving set which Blatterman modified for the purpose of his experiment. It served as an inductive coupling for passing the signals from the third amplifying tube to the fourth amplifying tube in the original set, and to the detector tube in the modified set. It constituted in the latter essential portions of the amplifying and detecting circuit and did not fairly respond to the additional hum eliminating means shown at 9a in the Lowell and Dunmore patent. This latter means is a condenser which is connected to the detector circuit, as shown in the patent drawing. Claims copied from a patent must be construed in the light of the patent disclosure. The provision of some other circuit arrangement not strictly within the terms of the copied claims but which is alleged to accomplish the same or similar results is not sufficient to entitle an applicant to make the copied claims (Gray v. Greene 1927 C. D. 104; 56 App. D. C. 387; 16 F (2d) 332), and likewise is insufficient to establish priority of invention.

We concur in the holding of the examiner that Blatterman's proofs do not establish either conception or reduction to practice prior to Blatterman's filing date of March 10, 1922, which is subsequent to the dates accorded Lowell and Dunmore.

We agree with the examiner that Lowell and Dunmore are joint inventors of the invention in issue. Furthermore,

the records do not support Duncan's contention that Lowell and Dunmore derived the invention from Duncan.

Lowell and Dunmore have filed a motion to amend their preliminary statement. If the findings we have made above are correct, the granting of the motion is not material to their right to the award of priority of invention. The examiner's decision denying this motion has already been affirmed by the First Assistant Commissioner (paper No. 132) who's findings are adopted here.

Pupin's request for recommendation under Rule 126 is denied.

[fol. 33] The decision of the Examiner of Interferences awarding priority of invention of the subject matter in issue to Lowell and Dunmore, a junior party, is affirmed.

Wm. A. Kinnan, First Assistant Commissioner; Eugene Landers, Examiner-in-Chief; P. P. Pierce, Examiner-in-Chief, Board of Appeals.

July 25, 1931.

[fol. 34] U. S. Patent Office, Board of Appeals. July 25, 1931. Mailed.

Received July 27, 1931. John B. Brady, Washington, D. C.

Appeal No. 4823

Hearing: May 12, 1931

OVT.

In the United States Patent Office,

Before the Board of Appeals

DUNCAN

vs.

LOWELL AND DUNMORE

Patent Interference No. 53,155 between an application of Robert D. Duncan, Jr. filed October 20, 1923, Serial No. 669,662, and a patent No. 1,455,141 granted Percival D. Lowell and Francis W. Dunmore, May 15, 1923, on an application filed March 27, 1922, Serial No. 547,111. Radio Receiving Apparatus.

Mr. Philip S. McLean for Duncan.

Mr. John B. Brady and Mr. John Boyie, Jr. for Lowell and Dunmore.

This is an appeal by the junior party, Duncan, from the decision of the Examiner of Interferences awarding priority of invention of the subject matter in issue to the senior party, Lowell and Dunmore.

The issue is stated in two counts of which count 1 will serve as an example. This count reads as follows:

[fol. 35] 1. In an apparatus for receiving radio signals the combination of a source of signal energy, means for amplifying said energy, means for rectifying said energy, means for reproducing said energy, a source of alternating current for supplying power to said amplifying means, and means connected in circuit with said reproducing means for eliminating the hum of said alternating current in the reproducing means.

The counts are copies of claims 20 and 21 of the Lowell and Dunmore patent No. 1,455,141, granted May 15, 1923, on an application filed March 27, 1922. Duncan did not file until after the issuance of said patent and he consequently bears the burden of establishing priority of invention beyond a reasonable doubt.

Both parties have taken proofs which have been introduced in the instant proceeding and also in companion interference No. 53,154, involving the same application and patent on closely related subject matter.

The examiner has held Lowell and Dunmore entitled to October 7, 1921, for conception and December 10, 1921, for reduction to practice. He has further held that if the counts are to be construed to apply to a device capable of receiving telephonic signals appellees are entitled to December 10, 1921, for conception and January 20, 1922, for reduction to practice. We deem all the above dates fairly established by appellees' record.

Regardless of whether the counts are readable on Duncan's Exhibit No. 15 circuit, it is our opinion, for the reasons stated in the examiner's decision and those stated in our decision of this date in companion interference No.

53,154, that Duncan is not entitled to the award of priority of invention in the instant proceeding.

We are of the opinion that the examiner did not err in considering Lowell and Dunmore to be joint inventors.

We adopt the decision of the First Assistant Commissioner (paper No. 74) affirming the decision of the examiner denying the motion of Lowell and Dunmore to amend their preliminary statement.

[fol. 36] The decision of the Examiner of Interferences awarding priority of invention of the subject matter in issue to Lowell and Dunmore, the senior party, is affirmed.

Wm. A. Kinnan, First Assistant Commissioner; Eugene Landers, Examiner-in-Chief; P. P. Pierce, Examiner-in-Chief, Board of Appeals.

July 25, 1931.

[fol. 37] U. S. Patent Office, Board of Appeals. July 25, 1931. Mailed.

Appeal Nos. 4818-19

Hearing: May 12, 1931

OVT.

In the United States Patent Office,

Before the Board of Appeals

PUPIN

v.

LOWELL

and

DUNMORE

v.

BLATTERMAN

Patent Interference No. 51,702 between an application of Michael Pupin filed February 4, 1924, Serial No. 690,586; the patent granted Percival D. Lowell and Francis W.

Dunmore, May 15, 1923, No. 1,455,141, on an application filed March 27, 1922, Serial No. 547,111; and an application of Albert S. Blatterman filed March 10, 1922, Serial No. 542,525. Radio Receiving Apparatus.

Mr. O. H. Eschholz and Messrs. F. W. Lyle and W. H. Whitten for Pupin.

Mr. John B. Brady and Mr. John Boyle for Lowell and Dunmore.

Dr. David P. Wolhaupter for Blatterman.

This case comes up on appeal from the decision of the Examiner of Interferences awarding priority of invention of the subject matter in issue to the party Lowell and Dunmore. Both the junior party Pupin and the senior party Blatterman have appealed.

[fol. 38] The issue is set forth in two counts of which count 1 will serve as an example. This count reads as follows:

1. In an apparatus for receiving radio signals the combination of a source of signal energy, means for amplifying said energy, means for rectifying said energy, a source of alternating current for supplying power to said amplifying means, means for rectifying said current, and a plurality of separate means connected in circuit with said rectifying means for smoothing out the rectified current and supplying power to said amplifying means.

The counts are copies of claims 16 and 1 of the Lowell and Dunmore patent No. 1,455,141, granted May 15, 1923, on an application filed March 27, 1922. Pupin did not file until after the patent issued, and consequently he bears the burden of establishing priority of invention beyond a reasonable doubt.

This case is one of a series of companion interferences Nos. 51,204; 51,702; 53,154 and 53,155, involving the Lowell and Dunmore patent and one or more of the applications of the parties Pupin, Duncan and Blatterman, the Duncan application not being involved in the instant interference. The records submitted by the several parties in the respective interferences in which their applications and patent are involved are the same.

Pupin is relying on the filing date, December 31, 1915, of his application Serial No. 69,566, which matured into patent No. 1,571,458, on February 2, 1926, for constructive reduction to practice. For reasons set forth at length in our decision of this date in companion interference No. 53,154, it is held that the disclosure in the 1915 Pupin application does not fairly support the issue in the instant interference, and accordingly that Pupin is not entitled to the award of priority of invention in this proceeding.

The examiner has accorded Lowell and Dunmore December 10, 1921, for conception and January 20, 1922, for reduction to practice of the invention defined by count 1. We consider these dates to be fairly established by their [fol. 39] proofs. He has further held them entitled to October 7, 1921, for conception and December 10, 1921, for reduction to practice as to count 2. We find no error in these holdings, but do not regard them as of particular moment, since, as will hereinafter appear, Lowell and Dunmore are entitled to the award of priority of invention in this proceeding if restricted for both counts to the dates accorded them for count 1.

The examiner held that the counts are readable on the circuit shown on page 21 of Blatterman's note book (Exhibits A and C). An enlarged view of this circuit has also been introduced as Exhibit E. The circuit is accompanied in the note book by a description of the test made. The entry is dated November 28, 1921. On page 22 is an additional entry signed by Henry Harris who participated in the test. This entry states the test was made on or about November 28, 1921, and that there was no a. c. hum with the set in tune for incoming signals.

The examiner on pages 4 to 6 of his decision has stated several circumstances which tend to discredit Blatterman's testimony relating to the test. We are satisfied for the reasons stated by him the test should not be held a reduction to practice of the circuit tested.

We also believe that the date of the test is not established as November 28, 1921, or any other date as early as December 10, 1921, to which Lowell and Dunmore are clearly entitled for conception. Harris is the only corroborating witness testifying about the test. He could not say from memory unassisted by the written date whether the event occurred late in November or early in December

(X Q. 77). While he stated he believed the test was made on November 28, 1921, and recorded in the note book on the same day, his testimony is in disagreement with that of Blatterman and with the written description to such extent as to clearly indicate he had no definite recollection as to what transpired. Blatterman testified he used the petentiometer which is regularly used in the SCR-122 set (Q. 13) while Harris testified he believed another potentiometer was used (X Q. 112). The written description in the note book says "Tried various condensers at C but [fol. 40] 2 mf. O. K. One mf. is too small. The bigger the better." Harris testified he did not believe change in the size of the condenser had any effect upon the amount of hum (X Q. 108). Blatterman testified he came directly from the laboratory in the research building into the office to write up the description (Q. 41) while Harris testified the writing was done in the same room where the tests were made (X Q. 110).

Blatterman did not leave the Government service at Camp Vail or Fort Monmouth until March 31, 1922 (Blatterman X Q. 198), and it was at this time he turned over his note book to Seibert, the specification engineer, who had charge of records at that place (Blatterman Q. 29; Seibert Q. 12). Harris may well have been requested to make the entry on page 22 of the note book at any time prior to April 1, 1922, and the fact that he stated in the entry that the test was made "on or about" is persuasive that his entry was not contemporaneous with the test but was made at a later date when he was not certain as to the date of the test. Insofar as the testimony of Blatterman's other witnesses, respecting work following the alleged November 28, 1921, test, is concerned said test could well have been made as late as December 15, 1921. As we view the case, Blatterman has no satisfactory corroboration establishing conception as early as December 10, 1921.

The examiner has held that assuming Blatterman was the first to conceive as to count 1, he still can not prevail because he was not exercising due diligence at the time Lowell and Dunmore entered the field. We consider this holding sound.

We adopt the decision of the First Assistant Commission (paper No. 127) affirming the decision of the examiner denying the motion of Lowell and Dunmore to amend their preliminary statement.

Pupin's request for recommendation under Rule 126 is denied.

[fol. 41] The decision of the Examiner of Interferences awarding priority of invention of the subject matter in issue to Lowell and Dunmore, a junior party, is affirmed.

Wm. A. Kinnan, First Assistant Commissioner; Eugene Landers, Examiner-in-Chief; P. P. Pierce, Examiner-in-Chief, Board of Appeals.

July 25, 1931.

[fol. 42] U. S. Patent Office, Board of Appeals. July 25, 1931, mailed.

Appeal No. 4825

Hearing: May 12, 1931

OVT.

In the United States Patent Office,

Before the Board of Appeals

LOWELL AND DUNMORE

vs.

BLATTERMAN

Patent Interference No. 51,204 between a patent No. 1,455,141 granted Percival D. Lowell and Francis W. Dunmore, May 15, 1923, on an application filed March 27, 1922, Serial No. 547,111; and an application of Albert S. Blatterman filed March 10, 1922, Serial No. 542,525. Radio Receiving Apparatus.

Mr. John B. Brady and Mr. John Boyle for Lowell & Dunmore.

Mr. David P. Wolhaupter for Blatterman.

This is an appeal by the senior party, Blatterman, from the decision of the Examiner of Interferences awarding priority of invention of the subject matter in issue to the junior party, Lowell and Dunmore.

The issue is stated in three counts, of which count 1 will serve as an example. This count reads as follows:

1. In an apparatus for the reception of radia signals the combination of a source of signal energy, a plurality of [fol. 43] vacuum tubes having grid, filament and plate electrodes, a detector, circuits interconnecting said electrodes and said detector, a transformer having a primary winding connected to a source of alternating current, secondary windings, a two electrode valve rectifier having a filament and a plate, connections between one of said secondary windings and the filament of said rectifier, connections between another of said secondary windings and said rectifier whereby direct current is suppied to the plate circuits of said vacuum tubes, another of said secondary windings connected to supply heating current to the filaments of said vacuum tubes and a capacity and resistance connected in said plate circuits for eliminating the hum of said alternating current in said apparatus.

The counts are copies of claims 15, 19 and 18 respectively of the Lowell and Dunmore patent No. 1,455,141.

This is one of a series of companion interferences Nos. 51,204; 51,702 and 53,154 involving said patent and Blatterman's application Serial No. 542,525, filed March 10, 1922. The issues in the three interferences are closely related. Both parties have taken proofs relating to all three interferences.

The examiner has accorded Lowell and Dunmore December 10, 1921, for conception and January 20, 1922, for reduction to practice. We concur in his holdings that their proofs fairly establish these dates.

Assuming that Blatterman's alleged test on November 28, 1921, involved the instant issue, as held by the examiner, we are satisfied that Blatterman is not entitled to the award of priority of invention in the instant proceeding. Our reasons for so holding are discussed in our decision of this date in companion interference No. 51,702, and need not be repeated herein.

Count 3 of the instant interference is the count of companion interference No. 53,153, which has been consolidated with the instant interference. We adopt the decision of denying the motion of Lowell and Dunmore to amend their the First Assistant Commissioner (paper No. 80 in inter-

ference No. 53,153) affirming the decision of the examiner preliminary statement.

[fols. 44-47] The decision of the examiner of interferences awarding priority of invention of the subject matter in issue to Lowell and Dunmore, the junior party, is affirmed.

Wm. A. Kinnan, First Assistant Commissioner; Eugene Landers, Examiner-in-Chief; P. P. Pierce, Examiner-in-Chief, Board of Appeals.

July 25, 1931.

[fol. 48] EXHIBIT "B"

Attached to Plaintiffs' Affidavit in Opposition to the Motion to Dismiss

Equity Bills Filed by the United States against Dubilier Condenser Corporation, Wilmington, Delaware; Morkrum Company, Portland, Maine; Percival D. Lowell, Brooklyn, New York; Francis W. Dunmore, Washington, D. C.; and Answers of the Defendants

Concerning the Socket Power Patents of Percival D. Lowell and Francis W. Dunmore, 1,455,141, May 15, 1923; 1,606,212, Nov. 9, 1926; 1,635,117, July 5, 1927

[fol. 49] For the Plaintiff:

United States of America, Charles B. Rugg, Assistant Attorney General; Alexander Holtzoff, Special Assistant to Atty. General.

For the Defendants:

Francis W. Dunmore—John B. Brady, Washington, D. C.; John Boyle, Jr., Washington, D. C., of Counsel; Wm. D. Shoemaker, Washington, D. C., of Counsel.

Percival D. Lowell—Raiemond E. Dee, New York City; John B. Brady, Washington, D. C., of Counsel.

Dubilier Condenser Corporation—James H. Hughes, Jr., Wilmington, Delaware; Edwards, Bower & Pool, New York City, of Counsel.

Morkrum Company—McLean, Fogg & Southard, Augusta, Maine; John B. Brady, Washington, D. C., of Counsel.

[fol. 50] IN THE DISTRICT COURT OF THE UNITED STATES FOR THE EASTERN DISTRICT OF NEW YORK

In Equity

No. 4934

UNITED STATES OF AMERICA, Plaintiff,

v.

PERCIVAL D. LOWELL, Defendant

BILL OF COMPLAINT

To the Honorable Judges of the District Court of the United States for the Eastern District of New York:

United States of America bring this bill of complaint against Percival D. Lowell, and for cause of action alleges:

I. This is a suit in equity brought by the United States of America as plaintiff.

II. As the plaintiff is informed and believes, the defendant Percival D. Lowell is a citizen of the State of New York and an inhabitant of the Eastern District of New York.

III. At all times hereinafter mentioned, the Bureau of Standards was and now is a subdivision of the Department of Commerce. The functions of said Bureau of Standards comprise the custody of standards; the comparison of the standards used with the standards adopted or recognized by the Government; the construction, the testing and the calibration of standards; and the conduct of scientific investigation, experimentation, studies and research in general.

IV. At all times hereinafter mentioned the Bureau of Standards maintained and now maintains a radio section. The said radio section carries on calibration of various radio instruments, and conducts scientific investigation, experiments, studies and research in the radio field and pre-
[fol. 51] pares and publishes scientific papers containing the results of its work for the purpose of disseminating knowledge to the parties interested therein and to the pub-

lic generally. For the purpose of carrying on its work the said radio section maintains a radio laboratory.

V. As the plaintiff is informed and believes, the defendant Percival D. Lowell is a physicist and is trained in carrying on research and experimentation in various branches of physics and the science of electricity, including radio. Between February 14, 1913, and July 15, 1922, the said defendant was employed in said radio section in the successive capacities of laboratory apprentice and associate physicist. It was one of the duties of said defendent to carry on investigation, research and experimentation in such problems relating to radio and wireless as might be assigned to him by his superiors, and to report the results thereof to his said superiors.

VI. In the course of his employment as aforesaid, there was assigned to said defendant Lowell by his superiors in said radio section, for investigation and research, the problem of developing an amplifier otherwise known as a "loudspeaker", capable of operation by alternating electric current as supplied by electric power companies for residences and other buildings.

VII. As the plaintiff is informed and believes, the said defendant Lowell pursuant to the aforesaid directions and instructions given him by his superiors, proceeded to carry on studies, research, investigation and experimentation in said problem. The aforesaid work was done by said defendant Lowell at said radio laboratory of the Bureau of Standards; with apparatus, and materials which were the property of the plaintiff, and during his usual hours of employment. The aforesaid work was done by said defendant Lowell as one of the duties of his employment as aforesaid, and the results and product of said work are the property of the plaintiff.

VIII. As the plaintiff is informed and believes, the said defendant Lowell was assisted in said work by one Francis [fol. 52] W. Dunmore. The said Dunmore was then also an employee of the Bureau of Standards, occupying a position similar to that of the defendant Lowell and performing duties similar to those of the said defendant. The said Dunmore so assisted and cooperated with the defendant Lowell at the direction and orders of his superiors.

IX. Some time prior to March 27, 1922, the defendant Lowell and the said Dunmore, solved the problem assigned to them by their superiors as aforesaid and completed the said work hereinabove referred to by developing and inventing an amplifier or "loud speaker" capable of being satisfactorily operated by alternating current received from the standard residence lighting power. The aforesaid development and invention, and all rights and interests therein are the property of the United States.

X. As the plaintiff is informed and believes, the defendant Percival D. Lowell and the said Francis W. Dunmore, in disregard of their duties to the plaintiff, and ignoring the rights of the plaintiff, and without the knowledge or approval of the plaintiff, filed in the United States Patent Office on March 21, 1922, application for letters patent on said invention. Thereafter on November 9, 1926, letters patent of the United States numbered 1,606,212 and covering the said invention were issued to said Percival D. Lowell and Francis W. Dunmore on the basis of the said application.

XI. The aforesaid letters patent are in equity and good conscience, the property of the United States. Although the plaintiff demanded of the defendant Lowell and the said Dunmore that the aforesaid letters patent be conveyed to the plaintiff, the said defendant Lowell and the said Dunmore have failed, neglected and refused to comply with said demand.

XII. As the plaintiff is informed and believes, the said defendant Lowell and the said Dunmore have unlawfully and illegally and in disregard of the plaintiff's rights purported to grant an exclusive license under the said letters patent to Dubilier Condenser Corporation, a corporation [fol. 53] organized and existing under the laws of the State of Delaware.

XIII. As the plaintiff is informed and believes, the said defendant Lowell and the said Dunmore have at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of said letters patent, which said moneys in equity and good conscience belong to the plaintiff, and the said defendant and the said Dunmore hold the same in trust and for the benefit of the plaintiff.

XIV. The said Francis W. Dunmore and Dubilier Condenser Corporation are not made parties to this action because they are not within the jurisdiction of this Court, in that as the plaintiff is informed and believes, the said Dunmore is an inhabitant of the District of Columbia and the said Dubilier Condenser Corporation is an inhabitant of the District of Delaware.

XV. The plaintiff has no remedy at law.

Wherefore the plaintiff prays this Honorable Court as follows:

1. That it be adjudged and decreed that the plaintiff is the owner of the invention hereinabove referred to and the defendant holds his interest therein as trustee and for the benefit of the plaintiff.

2. That it be adjudged and decreed that the plaintiff is the owner of letters patent of the United States 1,606,212 and issued on November 9, 1926, and that the defendant holds his interest as trustee and for the benefit of the plaintiff.

3. That the defendant be directed and compelled to assign, transfer, and convey to the plaintiff all his right, title and interest in and to the aforesaid invention and the aforesaid letters patent.

4. That the defendant be compelled and directed to account and pay over to the plaintiff all moneys received by him in connection with or arising out of the said invention and the said letters patent.

[fol. 54] 5. That the plaintiff have such other and further relief as to the court may seem just, together with the costs of this action.

6. That this Honorable Court issue its writ of subpoena in due form of law and according to the course and practice of this court directed to the said defendant Percival D. Lowell, commanding him at a certain date and under a certain penalty to be therein specified, to appear before this Honorable Court to answer all and singular the matters hereinbefore set forth and complained of and to stand by

and abide and perform all of the orders and decrees of the court herein.

Charles B. Rugg, Assistant Attorney General. Alexander Holtzoff, Special Assistant to the Attorney General. Howard W. Ameli, United States Attorney for the Eastern District of New York.

[fol. 55] State of New York,
County of Kings, ss:

Albert D. Smith, being duly sworn, deposes and says that he is an Assistant United States Attorney for the Eastern District of New York, duly appointed according to law.

That he has read the foregoing complaint and knows the contents thereof, and the same is true of his own knowledge, except as to those matters therein stated to be alleged upon information and belief, and as to those matters he believes it to be true.

Deponent further says that the reason why this verification is made by deponent and not by plaintiff is because the plaintiff is a corporation sovereign.

Deponent further says that the source of his information and the grounds for his belief as to the facts heretofore stated are from papers and information on file in this office.

Albert D. Smith.

Sworn to before me this 19th day of April, 1930.

Edw. A. Fay, United States Commissioner, Eastern District of New York.

[fol. 56] In the District Court of the United States for the Eastern District of New York

In Equity

No. 4934

United States of America, Plaintiff,

v.

Percival D. Lowell, Defendant

Answer

Now comes the defendant above named and answers plaintiff's bill of complaint as follows:

I. Defendant admits the allegations contained in paragraph I of the bill of complaint.

II. Defendant admits the allegations contained in paragraph II of the bill of complaint.

III. On information and belief defendant denies the allegations contained in paragraph III of plaintiff's bill of complaint.

IV. Answering paragraph IV of the bill of complaint defendant says that he has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

V. As to the allegations contained in paragraph V defendant admits the allegations contained in the first two sentences thereof but denies the allegations contained in the last sentence thereof.

VI. The defendant denies each and every of the allegations of numbered paragraph VI of the plaintiff's bill of complaint.

VII. Defendant denies each and every of the allegations of paragraph numbered VII of plaintiff's bill of complaint.

[fol. 57] VIII. Defendant denies each and every of the allegations of paragraph numbered VIII of plaintiff's bill of complaint.

IX. The defendant denies each and every of the allegations of paragraph numbered IX of the plaintiff's bill of complaint.

X. As to matters alleged in paragraph X of the bill of complaint defendant admits that on March 21, 1922 he jointly filed with Francis W. Dunmore an application for United States Letters Patent which issued as Number 1,606,212 on November 9, 1926. As to all other allegations of said paragraph X defendant denies the same.

XI. Defendant denies each and every of the allegations contained in paragraph XI of the bill of complaint and alleges that no officer or agency of the United States Government was or is authorized to acquire the invention of said Letters Patent 1,606,212 on behalf of the United States Government.

XII. The defendant admits that he granted with the said Dunmore a license to Dubilier Condenser Corporation but defendant denies each and every other allegation of paragraph XII of plaintiff's bill of complaint.

XIII. Answering paragraph XIII of plaintiff's bill of complaint, defendant admits that he has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of Letters Patent 1,606,212, but defendant denies that any of the said money belongs to plaintiff and denies that he holds the said money or any other property for the benefit of the plaintiff and further answering defendant avers that plaintiff has acquiesced in the collection and disbursement of said moneys and is not entitled to recover the same.

XIV. Answering paragraph XIV of plaintiff's bill of complaint defendant avers that he has no knowledge sufficient to form a belief and therefore neither affirms or denies the same and leaves the plaintiff to proof thereof if the allegations in said paragraph are deemed material.

[fol. 58] XV. Answering paragraph XV of plaintiff's bill of complaint defendant denies the allegation contained therein.

Wherefore having duly answered the bill of complaint this defendant denies that the plaintiff is entitled to the relief demanded or any part of the same and prays that the bill of complaint be dismissed with costs.

Percival D. Lowell. Raiemond E. Dee, Solicitor for Defendant. John B. Brady, of Counsel for Defendant.

County of Queens,
State of New York, ss:

Percival D. Lowell, being duly sworn, deposes and says that he is the defendant in this suit; that he has read the foregoing answer to the bill of complaint in this suit and knows the contents thereof and that the same is true to his own knowledge except as to the matters therein stated to be alleged upon information and belief and that as to those matters he believes it to be true.

Percival D. Lowell.

Sworn to and subscribed before me this 15th day of May, 1930.

Geo. H. Van Siclen, Notary Public. (Seal.)

[fol. 59] IN THE DISTRICT COURT OF THE UNITED STATES FOR THE EASTERN DISTRICT OF NEW YORK

In Equity.

No. 4935

UNITED STATES OF AMERICA, Plaintiff,

v.

PERCIVAL D. LOWELL, Defendant

BILL OF COMPLAINT

To the Honorable Judges of the District Court of the United States for the Eastern District of New York:

United States of America brings this its bill of complaint against Percival D. Lowell, and for cause of action alleges:

I. This is a suit in equity brought by the United States of America as plaintiff.

II. As the plaintiff is informed and believes, the defendant Percival L. Lowell is a citizen of the State of New York and an inhabitant of the Eastern District of New York.

III. At all times hereinafter mentioned, the Bureau of Standards was and now is a subdivision of the Department of Commerce. The functions of said Bureau of Standards comprise the custody of standards; the comparison of the standards used with the standards adopted or recognized by the Government; the construction, the testing and the calibration of standards; and the conduct of scientific investigation, experimentation, studies and research in general.

IV. At all times hereinafter mentioned the Bureau of Standards maintained and now maintains a radio section. The said radio section carries on calibration of various radio instruments, and conducts scientific investigation,

experiments, studies and research in the radio field, and prepares and publishes scientific papers containing the re- [fol. 60] sults of its work for the purpose of disseminating knowledge to the parties interested therein and to the public generally. For the purpose of carrying on its work the said radio section maintains a radio laboratory.

V. As the plaintiff is informed and believes, the defendant Percival D. Lowell is a physicist and is trained in carrying on research and experimentation in various branches of physics and the science of electricity, including radio. Between February 4, 1913, and July 15, 1922, the said defendant was employed in said radio section in the successive capacities of laboratory apprentice and associate physicist. It was one of the duties of said defendant to carry on investigation, research and experimentation in such problems relating to radio and wireless as might be assigned to him by his superiors, and to report the results thereof to his said superiors.

VI. In the course of his employment as aforesaid, there was assigned to said defendant Lowell by his superiors in said radio section, for investigation and research, the problem of developing a radio receiving set capable of operation by alternating electric current as supplied by electric power companies for residences and other buildings, so that the use of electric batteries might be eliminated in connection with radio receiving apparatus.

VII. As the plaintiff is informed and believes, the said defendant Lowell pursuant to the aforesaid directions and instructions given him by his superiors, proceeded to carry on studies, research, investigation and experimentation in said problem. The aforesaid work was done by said defendant Lowell at said radio laboratory of the Bureau of Standards; with apparatus and materials which were the property of the plaintiff; and during his usual hours of employment. The aforesaid work was done by said defendant Lowell as one of the duties of his employment as aforesaid, and the results and product of said work are the property of the plaintiff.

VIII. As the plaintiff is informed and believes, the said defendant Lowell was assisted in said work by one Francis

W. Dunmore. The said Dunmore was then also an em- [fol. 61] ployee of the Bureau of Standards, occupying a position similar to that of the defendant Lowell and performing duties similar to those of the said defendant. The said Dunmore so assisted and cooperated with the defendant Lowell at the direction and orders of his superiors.

IX. Some time prior to March 27, 1922, the defendant Lowell and the said Dunmore, solved the problem assigned to them by their superiors as aforesaid and completed the said work hereinabove referred to by developing and inventing a radio receiving apparatus capable of being satisfactorily operated by alternating current received from the standard residence lighting power. The aforesaid development and invention, and all rights and interests therein are the property of the United States.

X. As the plaintiff is informed and belives, the defendant Percival D. Lowell and the said Francis W. Dunmore, in disregard of their duties to the plaintiff, and ignoring the rights of the plaintiff, and without the knowledge or approval of the plaintiff, filed in the United States Patent Office on March 27, 1922, an application for letters patent on said invention. Thereafter on May 15, 1923, letters patent of the United States numbered 1,455,141 and covering the said invention were issued to said Percival D. Lowell and Francis W. Dunmore on the basis of the said application.

XI. The aforesaid letters patent are in equity and good conscience, the property of the United States. Although the plaintiff demanded of the defendant Lowell and the said Dunmore that the aforesaid letters patent be conveyed to the plaintiff, the said defendant Lowell and the said Dunmore have failed, neglected and refused to comply with said demand.

XII. As the plaintiff is informed and believes, the said defendant Lowell and the said Dunmore have unlawfully and illegally and in disregard of the plaintiff's rights purported to grant an exclusive license under the said letters patent to Dubilier Condenser Corporation, a corporation organized and existing under the laws of the State of Delaware.

[fol. 62] XIII. As the plaintiff is informed and believes, the said defendant Lowell and the said Dunmore have at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of said letters patent, which said moneys in equity and good conscience belong to the plaintiff, and the said defendant and the said Dunmore hold the same in trust and for the benefit of the plaintiff.

XIV. The said Francis W. Dunmore and Dubilier Condenser Corporation are not made parties to this action because they are not within the jurisdiction of this Court, in that, as the plaintiff is informed and believes, the said Dunmore is an inhabitant of the District of Columbia and the said Dubilier Condenser Corporation is an inhabitant of the District of Columbia.

XV. The plaintiff has no remedy at law.

Wherefore, the plaintiff prays this Honorable Court as follows:

1. That it be adjudged and decreed that the plaintiff is the owner of the invention hereinabove referred to and the defendant holds his interest therein as trustee and for the benefit of the plaintiff.

2. That it be adjudged and decreed that the plaintiff is the owner of letters patent of the United States numbered 1,455,141 and issued on May 15, 1923, and that the defendant holds his interest therein as trustee and for the benefit of the plaintiff.

3. That the defendant be directed and compelled to assign, transfer, and convey to the plaintiff all his right, title and interest in and to the aforesaid invention and the aforesaid letters patent.

4. That the defendant be compelled and directed to account and pay over to the plaintiff all moneys received by him in connection with or arising out of the said invention and the said letters patent.

[fol. 63] 5. That the plaintiff have such other and further relief as to the court may seem just, together with the cost of this action.

6. That this Honorable Court issue its writ of subpœna in due form of law and according to the court and practice of this court directed to the said defendant Percival D. Lowell, commanding him at a certain date and under a certain penalty to be therein specified, to appear before this Honorable Court to answer all and singular the matters hereinbefore set forth and complained of and to stand by and abide and perform all of the orders and decrees of the court herein.

Charles B. Rugg, Assistant Attorney General. Alexander Holtzoff, Special Assistant to the Attorney General, of Counsel. Howard W. Ameli, United States Attorney for the Eastern District of New York.

[fol. 64] STATE OF NEW YORK,
County of Kings, ss:

Albert D. Smith, being duly sworn, deposes and says that he is an Assistant United States Attorney for the Eastern District of New York, duly appointed according to law.

That he has read the foregoing complaint and knows the contents thereof, and the same is true of his own knowledge, except as to those matters therein stated to be alleged upon information and belief, and as to those matters he believes it to be true.

Deponent further says that the reason why this verification is made by deponent and not by plaintiff is because the plaintiff is a corporation sovereign.

Deponent further says that the source of his information and the grounds for his belief as to the facts heretofore stated are from papers and information on file in this office.

Albert D. Smith.

Sworn to before me this 19th day of April, 1930.
Edw. A. Fay, United States Commissioner Eastern District of New York.

[fol. 65] IN THE DISTRICT COURT OF THE UNITED STATES FOR THE EASTERN DISTRICT OF NEW YORK

In Equity

No. 4935

UNITED STATES OF AMERICA, Plaintiff,

v.

PERCIVAL D. LOWELL, Defendant

ANSWER

Now comes the defendant above named and answers plaintiff's bill of complaint as follows:

I. Defendant admits the allegations contained in paragraph I of the bill of complaint.

II. Defendant admits the allegations contained in paragraph II of the bill of complaint.

III. On information and belief defendant denies the allegations contained in paragraph III of plaintiff's bill of complaint.

IV. Answering paragraph IV of the bill of complaint defendant says that he has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

V. As to the allegations contained in paragraph V, defendant admits the allegations contained in the first two sentences thereof but denies the allegations contained in the last sentence thereof.

VI. The defendant denies each and every of the allegations of numbered paragraph VI of the plaintiff's bill of complaint.

[fol. 66] VII. The defendant denies each and every of the allegations of numbered paragraph VII of the plaintiff's bill of complaint.

VIII. Defendant denies each and every of the allegations of numbered paragraph VIII of plaintiff's bill of complaint.

IX. The defendant denies each and every of the allegations of paragraph numbered IX of the plaintiff's bill of complaint.

X. As to matters alleged in paragraph X of the bill of complaint, defendant admits that on March 27, 1922 he jointly filed with Francis W. Dunmore an application for United States Letters Patent which issued as Number 1,455,141 on May 15, 1923. As to all other allegations of said paragraph X, defendant denies the same.

XI. Defendant denies each and every of the allegations contained in paragraph XI of the bill of complaint and alleges that no officer or agency of the United States Government was or is authorized to acquire the invention of said Letters Patent 1,455,141 on behalf of the United States Government.

XII. The defendant admits that he granted with the said Dunmore a license to Dubilier Condenser Corporation but defendant denies each and every other allegation of paragraph XII of plaintiff's bill of complaint.

XIII. Answering paragraph XIII of plaintiff's bill of complaint, defendant admits that he has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of Letters Patent 1,455,141, but defendant denies that any of the said money belongs to plaintiff and denies that he holds the said money or any other property for the benefit of the plaintiff and further answering defendant avers that plaintiff has acquiesced in the collection and disbursement of said moneys and is not entitled to recover the same.

XIV. Answering paragraph XIV of plaintiff's bill of complaint defendant avers that he has no knowledge suf- [fol. 67] ficient to form a belief and therefore neither affirms or denies the same and leaves the plaintiff to proof thereof if the allegations in said paragraph are deemed material.

XV. Answering paragraph XV of plaintiff's bill of complaint defendant denies the allegation contained therein.

Wherefore, having duly answered the bill of complaint, this defendant denies that the plaintiff is entitled to the relief demanded or any part of the same and prays that the bill of complaint be dismissed with costs.

Percival D. Lowell. Raiemond E. Dee, Solicitor for Defendant. John B. Brady, of Counsel for Defendant.

County of Queens,
State of New York, ss:

Percival D. Lowell, being duly sworn, deposes and says that he is the defendant in this suit; that he has read the foregoing answer to the bill of complaint in this suit and knows the contents thereof and that the same is true to his own knowledge except as to the matters therein stated to be alleged upon information and belief and that as to these matters he believes it to be true.

Percival D. Lowell.

Sworn to and subscribed before me this 15th day of May, 1930.

Geo. H. Van Siclen, Notary Public. (Seal.)

[fol. 68] In the Supreme Court of the District of Columbia

In Equity

No. 51322

United States of America, Plaintiff,

v.

Francis W. Dunmore, 3411 Rodman Street N. W., Defendant

Bill of Complaint

To the Supreme Court of the District of Columbia:

Plaintiffs state as follows:

I. This is a suit in equity brought by the United States of America as plaintiff.

II. As the plaintiff is informed and believes, the defendant Francis W. Dunmore is a citizen of the United States and a resident of the District of Columbia.

III. At all times hereinafter mentioned, the Bureau of Standards was and now is a subdivision of the Department of Commerce. The functions of said Bureau of Standards comprise the custody of standards; the comparison of the standards used with the standards adopted or recognized by the Government; the construction, the testing and the calibration of standards; and the conduct of scientific investigation, experimentation, studies, and research in general.

IV. At all times hereinafter mentioned the Bureau of Standards maintained and now maintains a radio section. The said radio section carries on calibration of various radio instruments, and conducts scientific investigation, experiments, studies and research in the radio field, and prepares and publishes scientific papers containing the results of its work for the purpose of disseminating knowledge to [fol. 69] the parties interested therein and to the public generally. For the purpose of carrying on its work the said radio section maintains a radio laboratory.

V. As the plaintiff is informed and believes, the defendant Francis W. Dunmore, is a physicist and is trained in carrying on research and experimentation in various branches of physics and the science of electricity, including radio. From January 14, 1918, to date the said defendant was employed in said radio section in the successive capacities of laboratory assistant and associate physicist. It was one of the duties of said defendant to carry on investigation, research and experimentation in such problems relating to radio and wireless as might be assigned to him by his superiors, and to report the results thereof to his said superiors, and to assist, advise and cooperate with other employees of said radio section in carrying on tasks assigned to them.

VI. Between February 4, 1913, and July 15, 1922, one Percival D. Lowell was employed in said radio section in a capacity similar to that of the defendant, his duties being the same as those of the defendant. In the course of his employment as aforesaid, there was assigned to said Low-

ell by his superiors in said radio section, for investigation and research, the problem of developing a radio receiving set capable of operation by alternating electric current as supplied by electric power companies for residences and other buildings, so that the use of electric batteries might be eliminated in connection with radio receiving apparatus.

VII. As the plaintiff is informed and believes, the said Lowell pursuant to the aforesaid directions and instructions given him by his superiors, proceeded to carry on studies, research, investigations and experimentation in said problem, and the defendant Dunmore assisted, advised and cooperated with the said Lowell in carrying on said work. The aforesaid work was done by the said Lowell and the defendant Dunmore at said radio laboratory of the Bureau of Standards, with apparatus and materials which were the property of the plaintiff and during their usual hours of employment. The aforesaid work was done by [fol. 70] said Lowell and the defendant Dunmore as one of the duties of their employment as aforesaid, and the results and product of said work are the property of the plaintiff.

VIII. Some time prior to March 27, 1922, the defendant Dunmore and the said Lowell, solved the aforesaid problem and completed the said work hereinbefore referred to by developing and inventing a radio receiving apparatus capable of being satisfactorily operated by alternating current received from the standard residence lighting power. The aforesaid development and invention, and all rights and interests therein are the property of the United States.

IX. As the plaintiff is informed and believes, the defendant Dunmore and the said Lowell, in disregard of their duties to the plaintiff, and ignoring the rights of the plaintiff, and without the knowledge or approval of the plaintiff, filed in the United States Patent Office on March 27, 1922, an application for letters patent on said invention. Thereafter on May 15, 1923, letters patent of the United States numbered 1,455,141, and covering the said invention were issued to said Percival D. Lowell and Francis W. Dunmore on the basis of the said application.

X. The aforesaid letters patent are in equity and good conscience, the property of the United States. Although

the plaintiff demanded of the defendant Dunmore and the said Lowell that the aforesaid letters patent be conveyed to the plaintiff, the said defendant Dunmore and the said Lowell have failed, neglected and refused to comply with said demand.

XI. As the plaintiff is informed and believes, the said defendant Dunmore and the said Lowell have unlawfully and illegally and in disregard of the plaintiff's rights purported to grant an exclusive license under the said letters patent to Dubilier Condenser Corporation, a corporation organized and existing under the laws of the State of Delaware.

XII. As the plaintiff is informed and believes, the said defendant Dunmore and the said Lowell have at various times collected and received various sums of money from [fol. 71] divers persons as royalties or license fees in connection with and arising out of said letters patent, which said moneys in equity and good conscience belong to the plaintiff, and the said defendant and the said Lowell hold the same in trust and for the benefit of the plaintiff.

XIII. The said Percival D. Lowell and Dubilier Condenser Corporation are not made parties to this action because they are not within the jurisdiction of this Court, in that as the plaintiff is informed and believes, the said Lowell is an inhabitant of the Eastern District of New York and the said Dubilier Condenser Corporation is an inhabitant of the District of Delaware.

XIV. The plaintiff has no remedy at law.

Wherefore, the plaintiff prays this Honorable Court as follows:

1. That it be adjudged and decreed that the plaintiff is the owner of the invention hereinabove referred to and the defendant holds his interest therein as trustee and for the benefit of the plaintiff.

2. That it be adjudged and decreed that the plaintiff is the owner of letters patent of the United States numbered 1,455,141 and issued on May 15, 1923, and that the defendant holds his interest therein as trustee and for the benefit of the plaintiff.

3. That the defendant be directed and compelled to assign, transfer, and convey to the plaintiff all his right, title and interest in and to the aforesaid invention and the aforesaid letters patent.

7. That the defendant be compelled and directed to account and pay over to the plaintiff all moneys received by him in connection with or arising out of the said invention and the said letters patent.

5. That the plaintiff have such other and further relief as to the court may seem just, together with the costs of this action.

[fol. 72] 6. That this Honorable Court issue its writ of subpoena in due form of law and according to the course and practice of this court directed to the said defendant Francis W. Dunmore, commanding him at a certain date and under a certain penalty to be therein specified, to appear before this Honorable Court to answer all and singular the matters hereinbefore set forth and complained of and to stand by and abide and perform all of the orders and decrees of the court herein.

Charles B. Rugg, Assistant Attorney General. Alexander Holtzoff, Special Assistant to the Attorney General, of Counsel. Leo A. Rover, United States Attorney for the District of Columbia.

[fol. 73] IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 51322

UNITED STATES OF AMERICA, Plaintiff,

v.

FRANCIS W. DUNMORE, Defendant

ANSWER

Now comes the defendant above named and answers plaintiff's bill of complaint as follows:

I. Defendant admits the allegations contained in paragraph I of the bill of complaint.

II. Defendant admits the allegations contained in paragraph II of the bill of complaint.

III. On information and belief defendant denies the allegations contained in paragraph III of plaintiff's bill of complaint.

IV. Answering paragraph IV of the bill of complaint defendant says that he has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

V. As to the allegations contained in paragraph V, defendant admits the allegations contained in the first two sentences thereof but denies the allegations contained in the last sentence thereof.

VI. The defendant denies each and every of the allegations of numbered paragraph VI of the plaintiff's bill of complaint.

VII. The defendant denies each and every of the allegations of numbered paragraph VII of the plaintiff's bill of complaint.

[fol. 74] VIII. The defendant denies each and every of the allegations of paragraph numbered VIII of the plaintiff's bill of complaint.

IX. As to matters alleged in paragraph IX of the bill of complaint, defendant admits that on March 27, 1922 he jointly filed with the said Percival D. Lowell an application for Letters Patent of the United States which issued as Letters Patent 1,455,141 on May 15, 1923. As to all other allegations of said paragraph IX defendant denies the same.

X. Defendant denies each and every of the allegations contained in paragraph X of the bill of complaint and alleges that no officer or agency of the United States Government was or is authorized to acquire the invention of said Letters Patent 1,455,141 on behalf of the United States Government.

XI. The defendant admits that he granted with the said Lowell a license to Dubilier Condenser Corporation but defendant denies each and every other allegation of paragraph XI of plaintiff's bill of complaint.

XII. Answering paragraph XII of plaintiff's bill of complaint, defendant admits that he has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of Letters Patent 1,455,141, but defendant denies that any of the said money belongs to plaintiff and denies that he holds the said money or any other property for the benefit of the plaintiff, and further answering, defendant avers that plaintiff has acquiesced in the collection and disbursement of said moneys and is not entitled to recover the same.

XIII. Answering paragraph XIII of plaintiff's bill of complaint defendant avers that he has no knowledge sufficient to form a belief and therefore neither affirms or denies the same and leaves the plaintiff to proof thereof if the allegations in said paragraph are deemed material.

XIV. Answering paragraph XIV of plaintiff's bill of complaint defendant denies the allegation contained therein.

[fol. 75] Wherefore, having duly answered the bill of complaint, this defendant denies that the plaintiff is entitled to the relief demanded or to any part of the same and prays that the bill of complaint be dismissed with costs.

Francis W. Dunmore. John B. Brady, Solicitor for Defendant.

City of Washington,
District of Columbia, ss:

Francis W. Dunmore, being duly sworn, deposes and says that he is the defendant in this suit, that he has read the foregoing answer to the bill of complaint in this suit and knows the contents thereof and that the same is true to his own knowledge except as to the matters therein stated to be alleged upon information and belief and that as to those matters he believes it to be true.

Francis W. Dunmore.

Sworn to and subscribed before me this 21st day of May, 1930.

James E. Brown, Notary Public, D. C. (Seal.)

My commission expires March 31st, 1931.

[fol. 76] IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity.

No. 51323

UNITED STATES OF AMERICA, Plaintiff,

v.

FRANCIS W. DUNMORE, Defendant.

BILL OF COMPLAINT

To the Supreme Court of the District of Columbia:

Plaintiffs state as follows:

I. This is a suit in equity brought by the United States of America as plaintiff.

II. As the plaintiff is informed and believes, the defendant Francis W. Dunmore is a citizen of the United States and a resident of the District of Columbia.

III. At all times hereinafter mentioned, the Bureau of Standards was and now is a subdivision of the Department of Commerce. The functions of said Bureau of Standards comprise the custody of standards; the comparison of the standards used with the standards adopted or recognized by the Government; the construction, the testing and the calibration of standards; and the conduct of scientific investigation, experimentation, studies and research in general.

IV. At all times herein after mentioned the Bureau of Standards maintained and now maintains a radio section. The said radio section carries on calibration of various radio instruments, and conducts scientific investigation, experiments, studies and research in the radio field, and

prepares and publishes scientific papers containing the results of its work for the purpose of disseminating knowledge to the parties interested therein and to the public generally. For the purpose of carrying on its work the said radio section maintains a radio laboratory.

[fol. 77] V. As the plaintiff is informed and believes, the defendant Francis W. Dunmore is a physicist and is trained in carrying on research and experimentation in various branches of physics and the science of electricity, including radio. From January 14, 1918, to date the said defendant was employed in said radio section in the successive capacities of laboratory assistant and associate physicist. It was one of the duties of said defendant to carry on investigation, research and experimentation in such problems relating to radio and wireless as might be assigned to him by his superiors, and to report the results thereof to his said superiors, and to assist, advise and cooperate with other employees of said radio section in carrying on tasks assigned to them.

VI. Between February 4, 1913, and July 15, 1922, one Percival D. Lowell, was employed in said radio section in a capacity similar to that of the defendant, his duties being the same as those of the defendant. In the course of his employment as aforesaid, there was assigned to said Lowell by his superiors in said radio section, for investigation and research, the problem of developing an amplifier otherwise known as a "loud speaker" capable of operation by alternating electric current as supplied by electric power companies for residences and other buildings, so that the use of electric batteries might be eliminated in connection with radio receiving apparatus.

VII. As the plaintiff is informed and believes, the said Lowell pursuant to the aforesaid directions and instructions given him by his superiors, proceeded to carry on studies, research, investigation and experimentation in said problem, and the defendant Dunmore assisted, advised and cooperated with the said Lowell in carrying on said work. The aforesaid work was done by the said Lowell and the defendant Dunmore at said radio laboratory of the Bureau of Standards, with apparatus and materials which were the property of the plaintiff and during their usual hours of employment. The aforesaid work was done by said Low-

ell and the defendant Dunmore as one of the duties of their employment as aforesaid, and the results and product of said work are the property of the plaintiff.

[fol. 78] VIII. Some time prior to March 21, 1922, the defendant Lowell and the said Dunmore, solved the problem assigned to them by their superiors as aforesaid and completed the said work hereinabove referred to by developing and inventing an amplifier or "loud speaker" capable of being satisfactorily operated by alternating current received from the standard residence lighting power. The aforesaid development and invention, and all rights and interests therein are the property of the United States.

IX. As the plaintiff is informed and believes, the defendant Percival D. Lowell and the said Francis W. Dunmore, in disregard of their duties to the plaintiff, and ignoring the rights of the plaintiff, and without the knowledge or approval of the plaintiff, filed in the United States Patent Office on March 21, 1922, application for letters patent on said invention. Thereafter on November 9, 1926, letters patent of the United States numbered 1,606,212 and covering the said invention was issued to said Percival D. Lowell and Francis W. Dunmore on the basis of the said application.

X. The aforesaid letters patent is in equity and good conscience, the property of the United States. Although the plaintiff demanded of the defendant Dunmore and the said Lowell that the aforesaid letters patent be conveyed to the plaintiff, the said defendant Dunmore and the said Lowell have failed, neglected and refused to comply with said demand.

XI. As the plaintiff is informed and believes, the said defendant Dunmore and the said Lowell have unlawfully and illegally and in disregard to the plaintiff's rights purported to grant an exclusive license under the said letters patent to Dubilier Condenser Corporation, a corporation organized and existing under the laws of the State of Delaware.

XII. As the plaintiff is informed and believes, the said defendant Dunmore and the said Lowell have at various times collected and received various sums of money from divers persons as royalties or license fees in connection

[fol. 79] with and arising out of said letters patent, which said moneys in equity and good conscience belong to the plaintiff, and the said defendant and the said Lowell hold the same in trust and for the benefit of the plaintiff.

XIII. The said Percival D. Lowell and Dubilier Condenser Corporation are not made parties to this action because they are not within the jurisdiction of this Court, in that as the plaintiff is informed and believes, that said Lowell is an inhabitant of the Eastern District of New York and the said Dubilier Condenser Corporation is an inhabitant of the District of Delaware.

XIV. The plaintiff has no remedy at law.

Wherefore, the plaintiff prays this Honorable Court as follows:

1. That it be adjudged and decreed that the plaintiff is the owner of the invention hereinabove referred to and the defendant holds his interests therein as trustee and for the benefit of the plaintiff.

2. That it be adjudged and decreed that the plaintiff is the owner of letters patent of the United States numbered 1,606,212 and issued on November 9, 1926, and that the defendant holds his interest therein as trustee and for the benefit of the plaintiff.

3. That the defendant be directed and compelled to assign, transfer, and convey to the plaintiff all his right, title and interest in and to the aforesaid invention and the aforesaid letters patent.

4. That the defendant be compelled and directed to account and pay over to the plaintiff all moneys received by him in connection with or arising out of the said invention and the said letters patent.

5. That the plaintiff have such other and further relief as to the court may seem just, together with the costs of this action.

[fol. 80] 6. That this Honorable Court issue its writ of subpœna in due form of law and according to the course and practice of this court directed to the said defendant Francis W. Dunmore, commanding him at a certain date

and under a certain penalty to be therein specified, to appear before this Honorable Court to answer all and singular the matters hereinbefore set forth and complained of and to stand by and abide and perform all of the orders and decrees of the court herein.

Charles B. Rugg, Assistant Attorney General. Alexander Holtzoff, Special Assistant to the Attorney General, of Counsel. Leo A. Rover, United States Attorney for the District of Columbia.

[fol. 81] IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 51323

UNITED STATES OF AMERICA, Plaintiff,

v.

FRANCIS W. DUNMORE, Defendant

ANSWER

Now comes the defendant above named and answers plaintiff's bill of complaint as follows:

1. Defendant admits the allegations contained in paragraph I of the bill of complaint.

II. Defendant admits the allegations contained in paragraph II of the bill of complaint.

III. On information and belief defendant denies the allegations contained in paragraph III of the bill of complaint.

IV. Answering paragraph IV of the bill of complaint defendant says that he has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

V. As to the allegations contained in paragraph V, defendant admits the allegations contained in the first two sentences thereof but denies the allegations contained in the last sentence thereof.

VI. The defendant denies each and every of the allegations of numbered paragraph VI of the plaintiff's bill of complaint.

VII. The defendant denies each and every of the allegations of numbered paragraph VII of the plaintiff's bill of complaint.

[fol. 82] VIII. The defendant denies each and every of the allegations of numbered paragraph VIII of the plaintiff's bill of complaint.

IX. As to matters alleged in paragraph IX of the bill of complaint, defendant admits that on March 21, 1922 he jointly filed with Percival D. Lowell an application for Letters Patent of the United States which issued as Number 1,606,212 on November 9, 1926. As to all other allegations in said paragraph IX defendant denies the same.

X. Defendant denies each and every of the allegations contained in paragraph X of the bill of complaint and alleges that no officer or agency of the United States Government was or is authorized to acquire the invention of said Letters Patent 1,606,212 on behalf of the United States Government.

XI. Defendant admits that he granted a license with the said Lowell to Dubilier Condenser Corporation but defendant denies each and every other allegation of paragraph XI of plaintiff's bill of complaint.

XII. Answering paragraph XII of plaintiff's bill of complaint, defendant admits that he has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of Letters Patent 1,606,212, but defendant denies that any of the said money belongs to plaintiff and denies that he holds the said money or any other property for the benefit of the plaintiff, and further answering, defendant avers that plaintiff has acquiesced in the collection and disbursement of said moneys and is not entitled to recover the same.

XIII. Answering paragraph XIII of plaintiff's bill of complaint, defendant avers that he has no knowledge sufficient to form a belief and therefore neither affirms or denies the same and leaves the plaintiff to proof thereof if the allegations in said paragraph XIII are deemed material.

XIV. Answering paragraph XIV of plaintiff's bill of complaint, defendant denies the allegation contained therein.

[fol. 83] Wherefore, having duly answered the bill of complaint, this defendant denies that the plaintiff is entitled to the relief demanded or to any part of the same and prays that the bill of complaint be dismissed with costs.

Francis W. Dunmore, John B. Brady, Solicitor for Defendant.

CITY OF WASHINGTON,
District of Columbia, ss:

Francis W. Dunmore, being duly sworn, deposes and says that he is the defendant in this suit; that he has read the foregoing answer to the bill of complaint in this suit and knows the contents thereof and that the same is true to his own knowledge except as to the matters therein stated to be alleged upon information and belief and that as to those matters he believes it to be true.

Francis W. Dunmore.

Sworn to and subscribed before me this 21st day of May, 1930.

James E. Brown, Notary Public, D. C. (Seal.)

My commission expires March 31st, 1931.

[fol. 84] IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 51,324

UNITED STATES OF AMERICA, Plaintiff,

v.

FRANCIS W. DUNMORE, 3411 Rodman St. N. W., Defendant

BILL OF COMPLAINT

To the Supreme Court of the District of Columbia:

Plaintiffs state as follows:

I. This is a suit in equity brought by the United States of America as plaintiff.

II. As the plaintiff is informed and believes, the defendant Francis W. Dunmore is a citizen of the United States and a resident of the District of Columbia.

III. At all times hereinafter mentioned, the Bureau of Standards was and now is a subdivision of the Department of Commerce. The functions of said Bureau of Standards comprise the custody of standards; the comparison of the standards used with the standards adopted or recognized by the Government; the construction, the testing and the calibration of standards; and the conduct of scientific investigation, experimentation, studies and research in general.

IV. At all times hereinafter mentioned the Bureau of Standards maintained and now maintains a radio section. The said radio section carries on calibration of various [fol. 85] radio instruments, and conducts scientific investigation, experiments, studies and research in the radio field, and prepares and publishes scientific papers containing the results of its work for the purpose of disseminating knowledge to the parties interested therein and to the public generally. For the purpose of carrying on its work the said radio section maintains a radio laboratory.

V. As the plaintiff is informed and believes, the defendant Francis W. Dunmore, is a physicist and is trained in carrying on research and experimentation in various branches of physics and the science of electricity, including radio. From January 14, 1918, to date the said defendant was employed in said radio section in the successive capacities of laboratory assistant and associate physicist. It was one of the duties of said defendant to carry on investigation, research and experimentation in such problems relating to radio and wireless as might be assigned to him by his superiors, and to report the results thereof to his said superiors, and to assist, advise and cooperate with other employees of said radio section in carrying on tasks assigned to them.

VI. In the course of his employment as aforesaid there was assigned to said defendant, Dunmore, by his superiors in said radio section for investigation and research, the problem of developing a relay in connection with radio receiving apparatus for the local or remote control of auxiliary apparatus.

VII. As the plaintiff is informed and believes, the said Dunmore pursuant to the aforesaid directions and instructions given him by his superiors, proceeded to carry on studies, research, investigations and experimentation in said problem, and the defendant Lowell assisted, advised and cooperated with the said Dunmore in carrying on said work. The aforesaid work was done by the said Dunmore at said radio laboratory of the Bureau of Standards, with apparatus and materials which were the property of the plaintiff and during his usual hours of employment. The aforesaid work was done by said Dunmore as one of the [fol. 86] duties of his employment as aforesaid, and the results and product of said work are the property of the plaintiff.

VIII. Some time prior to February 27, 1922, the defendant Dunmore solved the aforesaid problem and completed the said work hereinbefore referred to by developing an apparatus commonly known as a "radio relay". The aforesaid development and invention and all rights and interests therein are the property of the United States.

IX. As the plaintiff is informed and believes, the defendant Dunmore, in disregard of his duties to the plaintiff, and ignoring the rights of the plaintiff, and without the knowledge or approval of the plaintiff, filed in the United States Patent Office on February 27, 1922, an application for letters patent on said invention. Thereafter on July 5, 1927, letters patent of the United States numbered 1,635,117, and covering the said invention were issued to said Francis W. Dunmore on the basis of the said application.

X. The aforesaid letters patent are in equity and good conscience, the property of the United States. Although the plaintiff demanded of the defendant Dunmore that the aforesaid letters patent be conveyed to the plaintiff, the said defendant Dunmore has failed, neglected and refused to comply with said demand.

XI. As the plaintiff is informed and believes, the said defendant Dunmore has granted an exclusive license on the said letters patent to the Dubilier Condenser Corporation, a corporation organized and existing under the laws of the State of Delaware, in so far as they relate to radio broadcasting apparatus, and to Morkrum Company, a corporation organized and existing under the laws of the State of Maine, in so far as said letters patent relate to printing telegraph apparatus.

XII. As the plaintiff is informed and believes, the said defendant Dunmore has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of said letters patent, which said moneys in equity and good [fol. 87] conscience belong to the plaintiff, and the said defendant holds the same in trust and for the benefit of the plaintiff.

XIII. The said Dubilier Condenser Corporation and the said Morkrum Company are not made parties to this action because they are not within the jurisdiction of this court, in that the said Dubilier Condenser Corporation is an inhabitant of the District of Delaware and the said Morkrum Company is an inhabitant of the District of Maine.

XIV. The plaintiff has no remedy at law.

Wherefore, the plaintiff prays this Honorable Court as follows:

1. That it be adjudged and decreed that the plaintiff is the owner of the invention hereinabove referred to and the defendant holds his interest therein as trustee and for the benefit of the plaintiff.

2. That it be adjudged and decreed that the plaintiff is the owner of letters patent of the United States numbered 1,635,117 and issued on July 5, 1927, and that the defendant holds his interest therein as trustee and for the benefit of the plaintiff.

3. That the defendant be directed and compelled to assign, transfer, and convey to the plaintiff all his right, title and interest in and to the aforesaid invention and the aforesaid letters patent.

4. That the defendant be compelled and directed to account and pay over to the plaintiff all moneys received by him in connection with or arising out of the said invention and the said letters patent.

5. That the plaintiff have such other and further relief, as to the court may seem just, together with the costs of this action.

6. That this Honorable Court issue its writ of subpœna in due form of law and according to the course and practice of this court directed to the said defendant Francis W. Dunmore, commanding him at a certain date and under a [fol. 88] certain penalty to be therein specified, to appear before this Honorable Court to answer all and singular the matters hereinbefore set forth and complained of and to stand by and abide and perform all of the orders and decrees of the court herein.

Charles B. Rugg, Assistant Attorney General, Alexander Holtzoff, Special Assistant to the Attorney General, of Counsel. Leo A. Rover, United States Attorney for the District of Columbia.

[fol. 89] IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 51324

UNITED STATES OF AMERICA, Plaintiff,

v.

FRANCIS W. DUNMORE, Defendant

ANSWER

Now comes the defendant above named and answers plaintiff's bill of complaint as follows:

I. Defendant admits the allegation contained in paragraph I of the bill of complaint.

II. Defendant admits the allegations contained in paragraph II of the bill of complaint.

III. On information and belief defendant denies the allegations contained in paragraph III of the bill of complaint.

IV. Answering paragraph IV of the bill of complaint defendant says that he has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

V. As to the allegations contained in paragraph V, defendant admits the allegations contained in the first two sentences thereof but denies the allegations contained in the last sentence thereof.

VI. The defendant denies each and every of the allegations of numbered paragraph VI of the plaintiff's bill of complaint.

VII. The defendant denies each and every of the allegations of numbered paragraph VII of the plaintiff's bill of complaint.

[fol. 90] VIII. The defendant denies each and every of the allegations of numbered paragraph VIII of the plaintiff's bill of complaint.

IX. As to matters alleged in paragraph IX of the bill of complaint defendant admits that on February 27, 1922 he filed application for Letters Patent and secured thereon under date of July 5, 1927 Letters Patent of the United States numbered 1,635,117. As to all other allegations of said paragraph, defendant denies the same.

X. Defendant denies each and every of the allegations contained in paragraph X of the bill of complaint and alleges that no officer or agency of the United States Government was or is authorized to acquire the invention of the said Letters Patent 1,635,117 on behalf of the United States Government.

XI. The defendant admits that he has granted a license to the Dubilier Condenser Corporation and the Morkrum Company under Letters Patent 1,635,117, but denies each and every of the other allegations of paragraph XI.

XII. Answering paragraph XII of plaintiff's bill of complaint, defendant admits that he has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of Letters Patent 1,635,117, but defendant denies that any of the said money belongs to plaintiff and denies that he holds the said money or any other property for the benefit of the plaintiff, and further answering defendant avers that plaintiff has acquiesced in the collection and disbursement of said moneys and is not entitled to recover the same.

XIII. Answering paragraph XIII of palintiff's bill of complaint, defendant avers that he has no knowledge sufficient to form a belief and therefore neither affirms nor denies the same and leaves the plaintiff to proof thereof if the allegations in said paragraph are deemed material.

XIV. Answering paragraph XIV of the plaintiff's bill of complaint, defendant denies the allegation contained therein.

[fol. 91] Wherefore, having duly answered the bill of complaint, this defendant denies that the plaintiff is entitled

to the relief demanded or any part of the same and prays that the bill of complaint be dismissed with costs.

Francis W. Dunmore, John B. Brady, Solicitor for Defendant.

City of Washington,
District of Columbia, ss:

Francis W. Dunmore, being duly sworn, deposes and says that he is the defendant in this suit; that he has read the foregoing answer to the bill of complaint in this suit and knows the contents thereof and that the same is true to his own knowledge except as to the matters therein stated to be alleged upon information and belief and that as to those matters he believes it to be true.

Francis W. Dunmore.

Sworn to and subscribed before me this 21st day of May, 1930.

James E. Brown, Notary Public, D. C. (Seal.)

My commission expires March 31st, 1931.

[fol. 92] In the District Court of the United States for the District of Delaware

In Equity

No. 788

United States of America, Plaintiff,

v.

Dubilier Condenser Corporation, Defendant

Bill of Complaint

To the Honorable Judge of the District Court of the United States for the District of Delaware:

The United States of America brings this its bill of complaint against Dubilier Condenser Corporation, and for cause of action alleges:

I. This is a suit in equity brought by the United States of America as plaintiff.

II. As the plaintiff is informed and believes, the defendant Dubilier Condenser Corporation is a corporation organized under the laws of the State of Delaware and an inhabitant of the District of Delaware.

III. At all times hereinafter mentioned, the Bureau of Standards was and now is a subdivision of the Department of Commerce. The functions of said Bureau of Standards comprise the custody of standards; the comparison of the standards used with the standards adopted or recognized by the Government; the construction, the testing and the calibration of standards; and the conduct of scientific investigation, experimentation, studies and research in general.

IV. At all times hereinafter mentioned the Bureau of Standards maintained and now maintains a radio section. The said radio section carries on calibration of various radio instruments, and conducts scientific investigation, ex- [fol. 93] periments, studies and research in the radio field, and prepares and publishes scientific papers containing the results of its work for the purpose of disseminating knowledge to the parties interested therein and to the public generally. For the purpose of carrying on its work the said radio section maintains a radio laboratory.

V. As the plaintiff is informed and believes, one, Percival D. Lowell and, one, Francis W. Dunmore are physicists and are trained in carrying on research and experimentation in various branches of physics and the science of electricity, including radio. Between February 4, 1913, and July 15, 1922, the said Lowell was employed in said radio section in the successive capacities of laboratory apprentice and associate physicist. From January 14, 1918, to date, the said Dunmore was employed in said radio section in the successive capacities of laboratory assistant and associate physicist. It was one of the duties of said Lowell and of said Dunmore to carry on investigation, research and experimentation in such problems relating to radio and wireless as might be assigned to them by their superiors, and to report the results thereof to their said superiors, and to assist, advise and cooperate with other employees of said radio section in the performance of tasks assigned to them.

VI. In the course of his employment as aforesaid, there was assigned to the said Lowell by his superiors in said radio section, for investigation and research, the problem of developing a radio receiving set capable of operation by alternating electric current as supplied by electric power companies for residences and other buildings, so that the use of electric batteries might be eliminated in connection with radio receiving apparatus.

VII. As the plaintiff is informed and believes the said Lowell pursuant to the aforesaid directions and instructions given him by his superiors, proceeded to carry on studies, research, investigation and experimentation in said problems, and the said Dunmore advised, assisted and co-operated with said Lowell in the performance of the aforesaid work. The aforesaid work was done by said Lowell and [fol. 94] said Dunmore at said radio laboratory of the Bureau of Standards with apparatus and materials which were the property of the plaintiff; and during their usual hours of employment. The aforesaid work was done by said Lowell and said Dunmore as one of the duties of their employment as aforesaid, and the results and product of said work are the property of the plaintiff.

VIII. Some time prior to March 27, 1922, the said Lowell and the said Dunmore, solved the problem assigned to them by their superiors as aforesaid and completed the said work hereinabove referred to by developing and inventing a radio receiving apparatus capable of being satisfactorily operated by alternating current received from the standard residence lighting power. The aforesaid development and invention and all rights and interests therein are the property of the United States.

IX. As the plaintiff is informed and believes, the said Percival D. Lowell and the said Francis W. Dunmore, in disregard of their duties to the plaintiff, and ignoring the rights of the plaintiff, and without the knowledge or approval of the plaintiff, filed in the United States Patent Office on March 27, 1922, an application for letters patent on said invention. Thereafter on May 15, 1923, letters patent of the United States numbered 1,455,141 and covering the said invention were issued to the said Percival D. Lowell and Francis W. Dunmore on the basis of the said application.

X. The aforesaid letters patent are in equity and good conscience, the property of the United States. Although the plaintiff demanded that the aforesaid letters patent be conveyed to the plaintiff, such demand has not been complied with.

XI. As the plaintiff is informed and believes the said Lowell and the said Dunmore have unlawfully and illegally and in disregard of the plaintiff's rights purported to grant an exclusive license under the said letters patent to the defendant Dubilier Condenser Corporation.

[fol. 95] XII. As the plaintiff is informed and believes the defendant has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of said letters patent, which said moneys in equity and good conscience belong to the plaintiff and the said defendant holds the same in trust and for the benefit of the plaintiff.

XIII. The said Percival D. Lowell and Francis W. Dunmore are not made parties to this action because they are not within the jurisdiction of this Court, in that, as the plaintiff is informed and believes, the said Lowell is an inhabitant of the Eastern District of New York and the said Dunmore is an inhabitant of the District of Columbia.

XIV. The plaintiff has no remedy at law.

Wherefore, the plaintiff prays this Honorable Court as follows:

1. That it be adjudged and decreed that the plaintiff is the owner of the invention hereinabove referred to and the defendant holds its interest therein as trustee and for the benefit of the plaintiff.

2. That it be adjudged and decreed that the plaintiff is the owner of letters patent of the United States numbered 1,455,141 and issued on May 15, 1923, and that the defendant holds its interest therein as trustee and for the benefit of the plaintiff.

3. That the defendant be directed and compelled to assign, transfer and convey to the plaintiff all its right, title and interest in and to the aforesaid invention and the aforesaid letters patent.

4. That the defendant be compelled and directed to account and pay over to the plaintiff all moneys received by it in connection with or arising out of the said invention and the said letters patent.

5. That the plaintiff have such other and further relief as to the court may seem just, together with the costs of this action.

[fol. 96] 6. That this Honorable Court issue its writ of subpœna in due form of law and according to the course and practice of this court directed to the said defendant Dubilier Condenser Corporation, commanding it at a certain date and under a certain penalty to be therein specified, to appear before this Honorable Court to answer all and singular the matters hereinbefore set forth and complained of and to stand by and abide and perform all of the orders and decrees of the court herein.

Charles B. Rugg, Assistant Attorney General. Alexander Holtzoff, Special Assistant to the Attorney General, of Counsel. Leonard E. Wales, United States Attorney for the District of Delaware,

[fol. 97] IN THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF DELAWARE

In Equity

No. 788

UNITED STATES OF AMERICA, Plaintiff,

v.

DUBILIER CONDENSER CORPORATION, Defendant

ANSWER

Now comes the defendant above named and answers plaintiff's bill of complaint as follows:

I. Defendant admits the allegations contained in paragraph I of the bill of complaint.

II. Defendant admits the allegations contained in paragraph II of the bill of complaint.

III. Defendant denies each and every of the allegations contained in paragraph III of the bill of complaint.

IV. Answering paragraph IV of the bill of complaint defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

V. Answering paragraph V of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

VI. Answering paragraph VI of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither [fol. 98] admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

VII. Answering paragraph VII of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters alleged in the first two sentences therein, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said two sentences are deemed material. The defendant denies each and every of the other allegations contained in said paragraph numbered VII.

VIII. Answering paragraph VIII of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters alleged in the first sentence therein, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said sentence are deemed material. The defendant denies each and every of the other allegations contained in said paragraph numbered VIII.

IX. As to the matters alleged in paragraph IX of the bill of complaint, defendant admits that on March 27, 1922

one Percival D. Lowell and Francis W. Dunmore filed application for United States Letters Patent and secured thereon on May 15, 1923 Letters Patent of the United States numbered 1,455,141. As to all other matters in paragraph IX the defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

X. Defendant denies each and every of the allegations contained in paragraph X of the bill of complaint, and defendant further alleges that no officer or agency of the United States Government was or is authorized to acquire the invention of the Letters Patent 1,455,141 on behalf of the Government.

[fol. 99] XI. Answering paragraph XI of the bill of complaint, defendant admits that a license was granted to it under Letters Patent 1,455,141, and defendant denies each and every of the other allegations contained in said paragraph XI.

XII. Answering paragraph XII of the bill of complaint, defendant admits that it has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of Letters Patent numbered 1,455,141, but defendant denies that any of the said money belongs to plaintiff and denies that it holds the said money or any other property for the benefit of the plaintiff.

XIII. Answering paragraph XIII of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

XIV. Answering paragraph XIV of the plaintiff's bill of complaint, defendant denies the allegations contained therein.

Wherefore, having duly answered the bill of complaint, this defendant denies that the plaintiff is entitled to the

relief demanded or to any part of the same and prays that the bill of complaint be dismissed with costs.

Dubilier Condenser Corporation, by Roy E. Sweney, Secretary-Treasurer. James H. Hughes, Jr., Solicitor for Defendant. Edwards, Bower and Pool, of Counsel for Defendant.

[fol. 100] State of New York,
County of Bronx, ss:

Roy E. Sweney, being duly sworn, deposes and says that he is Secretary-Treasurer of the Dubilier Condenser Corporation, the defendant in this suit, that he has read the foregoing answer to the bill of complaint in this suit and knows the contents thereof and that the same is true of his own knowledge except as to the matters therein stated to be alleged upon information and belief, and as to those matters he believes it to be true.

Roy E. Sweney.

Sworn to and subscribed before me this 20th day of May, 1930.

R. I. MacGeorge, Notary Public. (Notarial Seal.)
Notary Public, N. Y. Co. 573.
N. Y. Co. Reg. No. 1-M-734.
Bronx Co. Reg. No. 3122-B.
Bronx Co. Clerk No. 76.
Commission expires March 30, 1931.

[fol. 101] In the District Court of the United States for the District of Delaware

In Equity

No. 789

United States of America, Plaintiff,

v.

Dubilier Condenser Corporation, Defendant

Bill of Complaint

To the Honorable Judge of the District Court of the United States for the District of Delaware:

The United States of America brings this its bill of complaint against Dubilier Condenser Corporation, and for cause of action alleges:

I. This is a suit in equity brought by the United States of America as plaintiff.

II. As the plaintiff is informed and believes, the defendant Dubilier Condenser Corporation is a corporation organized under the laws of the State of Delaware and an inhabitant of the District of Delaware.

III. At all times hereinafter mentioned, the Bureau of Standards was and now is a subdivision of the Department of Commerce. The functions of said Bureau of Standards comprise the custody of standards; the comparison of the standards used with the standards adopted or recognized by the Government; the construction, the testing and the calibration of standards; and the conduct of scientific investigation, experimentation, studies and research in general.

IV. At all times hereinafter mentioned the Bureau of Standards maintained and now maintains a radio section. The said radio section carries on calibration of various [fol. 102] radio instruments, and conducts scientific investigation, experiments, studies and research in the radio field, and prepares and publishes scientific papers containing the results of its work for the purpose of disseminating knowledge to the parties interested therein and to the public generally. For the purposes of carrying on its work the said radio section maintains a radio laboratory.

V. As the plaintiff is informed and believes, one, Percival D. Lowell and, one, Francis W. Dunmore are physicists and are trained in carrying on research and experimentation in various branches of physics and the science of electricity, including radio. Between February 4, 1913, and July 15, 1922, the said Lowell was employed in said radio section in the successive capacities of laboratory apprentice and associate physicist. From January 14, 1918, to date, the said Dunmore was employed in said radio section in the successive capacities of laboratory assistant and associate physicist. It was one of the duties of said Lowell and of said Dunmore to carry on investigation, research and experimentation in such problems relating to radio and wireless as might be assigned to them by their superiors, and to report the results thereof to their said superiors, and to assist, advise and cooperate with other employees

of said radio section in the performance of tasks assigned to them.

VI. In the course of his employment as aforesaid, there was assigned to said Lowell by his superiors in said radio section, for investigation and research, the problem of developing an amplifier, otherwise known as a "loud speaker", capable of operation by alternating electric current as supplied by electric power companies for residences and other buildings.

VII. As the plaintiff is informed and believes the said Lowell pursuant to the aforesaid directions and instructions given him by his superiors, proceeded to carry on studies, research, investigation and experimentation in said problems, and the said Dunmore advised, assisted and cooperated with said Lowell in the performance of the aforesaid work. The aforesaid work was done by said Lowell [fol. 103] and said Dunmore at said radio laboratory of the Bureau of Standards with apparatus and materials which were the property of the plaintiff; and during their usual hours of employment. The aforesaid work was done by said Lowell and said Dunmore as one of the duties of their employment as aforesaid, and the results and product of said work are the property of the plaintiff.

VIII. Sometime prior to March 21, 1922, the said Lowell and the said Dunmore solved the problem assigned to them by their superiors as aforesaid and completed the said work hereinabove referred to by developing and inventing an amplifier or "loud speaker", capable of being satisfactorily operated by alternating current received from the standard residence lighting power. The aforesaid development and invention and all rights and interests therein are the property of the United States.

IX. As the plaintiff is informed and believes, the said Percival D. Lowell and the said Francis W. Dunmore, in disregard of their duties to the plaintiff, and ignoring the rights of the plaintiff, and without the knowledge or approval of the plaintiff, filed in the United States Patent Office on March 21, 1922, an application for letters patent on said invention. Thereafter on November 9, 1926, letters patent of the United States numbered 1,606,212 and covering the said invention were issued to the said Percival D.

Lowell and Francis W. Dunmore on the basis of the said application.

X. The aforesaid letters patent are in equity and good conscience, the property of the United States. Although the plaintiff demanded that the aforesaid letters patent be conveyed to the plaintiff, such demand has not been complied with.

XI. As the plaintiff is informed and believes the said Lowell and the said Dunmore have unlawfully and illegally and in disregard of the plaintiff's rights purported to grant an exclusive license under the said letters patent to the defendant Dubilier Condenser Corporation.

[fol. 104] XII. As the plaintiff is informed and believes the defendant has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of said letters patent, which said moneys in equity and good conscience belong to the plaintiff and the said defendant holds the same in trust and for the benefit of the plaintiff.

XIII. The said Percival D. Lowell and Francis W. Dunmore are not made parties to this action because they are not within the jurisdiction of this Court, in that, as the plaintiff is informed and believes, the said Lowell is an inhabitant of the Eastern District of New York and the said Dunmore is an inhabitant of the District of Columbia.

XIV. The plaintiff has no remedy at law.

Wherefore, the plaintiff prays this Honorable Court as follows:

1. That it be adjudged and decreed that the plaintiff is the owner of the invention hereinabove referred to and the defendant holds its interest therein as trustee and for the benefit of the plaintiff.

2. That it be adjudged and decreed that the plaintiff is the owner of letters patent of the United States numbered 1,606,212 and issued on November 9, 1926, and that the defendant holds its interest therein as trustee and for the benefit of the plaintiff.

3. That the defendant be directed and compelled to assign, transfer and convey to the plaintiff all its right, title

and interest in and to the aforesaid invention and the aforesaid letters patent.

4. That the defendant be compelled and directed to account and pay over to the plaintiff all moneys received by it in connection with or arising out of the said invention and the said letters patent.

5. That the plaintiff have such other and further relief as to the court may seem just, together with the costs of this action.

[fol. 105] 6. That this Honorable Court issue its writ of subpoena in due form of law and according to the course and practice of this court directed to the said defendant Dubilier Condenser Corporation, commanding it at a certain date and under a certain penalty to be therein specified, to appear before this Honorable Court to answer all and singular the matters hereinbefore set forth and complained of and to stand by and abide and perform all of the orders and decrees of the court herein.

Charles B. Rugg, Assistant Attorney General. Alexander Holtzloff, Special Assistant to the Attorney General, of Counsel. Leonard E. Wales, United States Attorney for the District of Delaware.

[fol. 106] IN THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF DELAWARE

In Equity

No. 789

UNITED STATES OF AMERICA, Plaintiff,

v.

DUBILIER CONDENSER CORPORATION, Defendant

ANSWER

Now comes the defendant above named and answers plaintiff's bill of complaint as follows:

I. Defendant admits the allegations contained in paragraph I of the bill of complaint.

II. Defendant admits the allegations contained in paragraph II of the bill of complaint.

III. Defendant denies each and every of the allegations contained in paragraph III of the bill of complaint.

IV. Answering paragraph IV of the bill of complaint defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

V. Answering paragraph V of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

VI. Answering paragraph VI of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither [fol. 107] admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

VII. Answering paragraph VII of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters alleged in the first two sentences therein, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said two sentences are deemed material. The defendant denies each and every of the other allegations contained in said paragraph numbered VII.

VIII. Answering paragraph VIII of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters alleged in the first sentence therein, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said sentence are deemed material. The defendant denies each and every of the other allegations contained in said paragraph numbered VIII.

IX. As to the matters alleged in paragraph IX of the bill of complaint, defendant admits that on March 21, 1922

one Percival D. Lowell and Francis W. Dunmore filed application for United States Letters Patent and secured thereon on November 9, 1926 Letters Patent of the United States numbered 1,606,212. As to all other matters in paragraph IX the defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

X. Defendant denies each and every of the allegations contained in paragraph X of the bill of complaint, and defendant further alleges that no officer or agency of the United States Government was or is authorized to acquire the invention of the Letters Patent 1,606,212 on behalf of the Government.

[fol. 108] XI. Answering paragraph XI of the bill of complaint, defendant admits that a license was granted to it under Letters Patent 1,606,212, and defendant denies each and every of the other allegations contained in said paragraph XI.

XII. Answering paragraph XII of the bill of complaint, defendant admits that it has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of Letters Patent numbered 1,606,212, but defendant denies that any of the said money belongs to plaintiff and denies that it holds the said money or any other property for the benefit of the plaintiff.

XIII. Answering paragraph XIII of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

XIV. Answering paragraph XIV of the plaintiff's bill of complaint, defendant denies the allegations contained therein.

Wherefore, having duly answered the bill of complaint, this defendant denies that the plaintiff is entitled to the re-

lief demanded or to any part of the same and prays that the bill of complaint be dismissed with costs.

Dubilier Condenser Corporation, by Roy E. Sweney, Secretary-Treasurer. James H. Hughes, Jr., Solicitor for Defendant. Edwards, Bower and Pool, of Counsel for Defendant.

[fol. 109] State of New York,
County of Bronx, ss:

Roy E. Sweney, being duly sworn, deposes and says that he is Secretary-Treasurer of the Dubilier Condenser Corporation, the defendant in this suit, that he has read the foregoing answer to the bill of complaint in this suit and knows the contents thereof, and that the same is true of his own knowledge except as to the matters therein stated to be alleged upon information and belief, and as to those matters he believes it to be true.

Roy E. Sweney,

Subscribed and sworn to before me this 20th day of May, 1930.

R. I. MacGeorge, Notary Public. (Notarial Seal.)
Notary Public N. Y. Co. No. 573.
N. Y. Co. Reg. No. 1-M-734.
Bronx Co. Clerk No. 76.
Bronx Co. Reg. No. 3122-B.
Commission expires March 30, 1931.

[fol. 110] In the District Court of the United States for the District of Delaware

In Equity

No. 790

United States of America, Plaintiff,

v.

Dubilier Condenser Corporation, Defendant

Bill of Complaint

To the Honorable Judge of the District Court of the United States for the District of Delaware:

The United States of America brings this its bill of complaint against Dubilier Condenser Corporation, and for cause of action alleges:

I. This is a suit in equity brought by the United States of America as plaintiff.

II. As the plaintiff is informed and believes, the defendant Dubilier Condenser Corporation is a corporation organized under the laws of the State of Delaware and an inhabitant of the District of Delaware.

III. At all times hereinafter mentioned, the Bureau of Standards was and now is a subdivision of the Department of Commerce. The functions of said Bureau of Standards comprise the custody of standards; the comparison of the standards used with the standards adopted or recognized by the Government; the construction, the testing and the calibration of standards; and the conduct of scientific investigation, experimentation, studies and research in general.

[fol. 111] IV. At all times hereinafter mentioned the Bureau of Standards maintained and now maintains a radio section. The said radio section carries on calibration of various radio instruments, and conducts scientific investigation, experiments, studies and research in the radio field, and prepares and publishes scientific papers containing the results of its work for the purpose of disseminating knowledge to the parties interested therein and to the public generally. For the purpose of carrying on its work the said radio section maintains a radio laboratory.

V. As the plaintiff is informed and believes, one Francis W. Dunmore is a physicist and is trained in carrying on research and experimentation in various branches of physics and the science of electricity, including radio. From January 14, 1918, to date, the said Dunmore was employed in said radio section in the successive capacities of laboratory assistant and associate physicist. It was one of the duties of said Dunmore to carry on investigation, research and experimentation in such problems relating to radio and wireless as might be assigned to him by his superiors and to report the results thereof to his said superiors.

VI. In the course of his employment as aforesaid, there was assigned to said Dunmore by his superiors in said radio section, for investigation and research, the problem

of developing a radio receiving system operating a relay for the local or remote control of auxiliary apparatus.

VII. As the plaintiff is informed and believes, the said Dunmore pursuant to the aforesaid directions and instructions given him by his superiors proceeded to carry on studies, research, investigation and experimentation in said problem. The aforesaid work was done by said Dunmore at said radio laboratory of the Bureau of Standards with apparatus and materials which were the property of the plaintiff, and during his usual hours of employment. The aforesaid work was done by said Dunmore as one of the duties of his employment as aforesaid, and the results and product of said work is the property of the plaintiff.

[fol. 112] VIII. Sometime prior to the 27th day of February, 1922, the said Dunmore solved the problem assigned to him by his superiors as aforesaid and completed the said work hereinabove referred to by developing and inventing an apparatus known as a "radio relay". The aforesaid development and invention and all rights and interests therein are the property of the United States.

IX. As the plaintiff is informed and believes, the said Dunmore in disregard of his duties to the plaintiff and ignoring the rights of the plaintiff, and without the knowledge or approval of the plaintiff, filed in the United States Patent Office on February 27, 1922, an application for letters patent on said invention. Thereafter on July 5, 1927, letters patent of the United States numbered 1,635,117, and covering the said invention were issued to said Francis W. Dunmore on the basis of the said application.

X. The aforesaid letters patent are in equity and good conscience, the property of the United States. Although the plaintiff demanded that the aforesaid letters patent be conveyed to the plaintiff, such demand has not been complied with.

XI. As the plaintiff is informed and believes the said Dunmore has unlawfully and illegally and in disregard of the plaintiff's rights purported to grant an exclusive license under the said letters patent to the defendant Dubilier Condenser Corporation, in so far as the said letters patent cover radio telephone broadcast receiving apparatus; and to Morkrum Company, a corporation organized and exist-

ing under the laws of the State of Maine, in so far as the device covered thereby may be used with printing telegraph apparatus.

XII. As the plaintiff is informed and believes the defendant has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of said letters patent, which said moneys in equity and good conscience belong to the plaintiff and the said defendant holds the same in trust and for the benefit of the plaintiff.

[fol. 113] XIII. The said Francis W. Dunmore and Morkrum Company are not made parties to this action because they are not within the jurisdiction of this Court in that, as the plaintiff is informed and believes, the said Dunmore is an inhabitant of the District of Columbia and the said Morkrum Company is an inhabitant of the District of Maine.

XIV. The plaintiff has no remedy at law.

Wherefore, the plaintiff prays this Honorable Court as follows:

1. That it be adjudged and decreed that the plaintiff is the owner of the invention hereinabove referred to and the defendant holds its interest therein as trustee and for the benefit of the plaintiff.

2. That it be adjudged and decreed that the plaintiff is the owner of letters patent of the United States numbered 1,635,117, and issued on July 5, 1927, and that the defendant holds its interest therein as trustee and for the benefit of the plaintiff.

3. That the defendant be directed and compelled to assign, transfer and convey to the plaintiff all its right, title and interest in and to the aforesaid invention and the aforesaid letters patent.

4. That the defendant be compelled and directed to account and pay over to the plaintiff all moneys received by it in connection with or arising out of the said invention and the said letters patent.

5. That the plaintiff have such other and further relief as to the court may seem just, together with the costs of this action.

6. That this Honorable Court issue its writ of subpoena in due form of law and according to the course and practice of this court directed to the said defendant Dubilier Condenser Corporation, commanding it at a certain date and under a certain penalty to be therein specified, to appear before this Honorable Court to answer all and singular the [fol. 114] matters hereinbefore set forth and complained of and to stand by and abide and perform all of the orders and decrees of the court herein.

(Sgd.) Charles B. Rugg, Assistant Attorney General. (Sgd.) Alexander Holtzoff, Special Assistant to the Attorney General, of Counsel. (Sgd.) Leonard E. Wales, United States Attorney for the District of Delaware.

A true copy—Attest:

H. C. Mahaffy, Jr., Clerk.

[fol. 115] IN THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF DELAWARE

Equity No. 790

UNITED STATES OF AMERICA, Plaintiff,

v.

DUBILIER CONDENSER CORPORATION, Defendant

ANSWER

Now comes the defendant above named and answers plaintiff's bill of complaint as follows:

I. Defendant admits the allegations contained in paragraph I of the bill of complaint.

II. Defendant admits the allegations contained in paragraph II of the bill of complaint.

III. Defendant denies each and every of the allegations contained in paragraph III of the bill of complaint.

IV. Answering paragraph IV of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

V. Answering paragraph V of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

V. Answering paragraph VI of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither [fol. 116] admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

VII. Answering paragraph VII of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters alleged in the first two sentences therein, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may advise if the allegations in said two sentences are deemed material. The defendant denies each and every of the other allegations contained in said paragraph numbered VII.

VIII. Answering paragraph VIII of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters alleged in the first sentence therein, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may advise if the allegations in said sentence are deemed material. The defendant denies each and every of the other allegations contained in said paragraph numbered VIII.

IX. As to the matters alleged in paragraph IX of the bill of complaint, defendant admits that on February 27, 1922 one Francis W. Dunmore filed application for United States Letters Patent and secured thereon on February 5,

1927 Letters Patent of the United States numbered 1,635,-117. As to all other matters in paragraph IX the defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

X. Defendant denies each and every of the allegations contained in paragraph X of the bill of complaint, and defendant further alleges that no officer or agency of the United States Government was or is authorized to acquire the invention of the Letters Patent 1,635,117 on behalf of the Government.

[fol. 117] XI. Answering paragraph XI of the bill of complaint, defendant admits that a license was granted to it and to the Morkrum Company under the Letters Patent number 1,635,117, and defendant denies each and every of the other allegations contained in the said paragraph XI.

XII. Answering paragraph XII of the bill of complaint, defendant admits that it has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of Letters Patent numbered 1,635,117, but defendant denies that any of the said money belongs to plaintiff and denies that it holds the said money or any other property for the benefit of the plaintiff.

XIII. Answering paragraph XIII of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

XIV. Answering paragraph XIV of the plaintiff's bill of complaint, defendant denies the allegations contained therein.

Wherefore having duly answered the bill of complaint, this defendant denies that the plaintiff is entitled to the

relief demanded or to any part of the same and prays that the bill of complaint be dismissed with costs.

Dubilier Condenser Corporation, by Roy E. Sweney, Secretary-Treasurer. James H. Hughes, Jr., Solicitor for Defendant. Edwards, Bower and Pool, of Counsel for Defendant.

[fol. 118] STATE OF NEW YORK,
County of Bronx, ss:

Roy E. Sweney, being duly sworn, deposes and says that he is Secretary-Treasurer of the Dubilier Condenser Corporation, the defendant in this suit, that he has read the foregoing answer to the bill of complaint in this suit and knows the contents thereof and that the same is true of his own knowledge except as to the matters therein stated to be alleged upon information and belief, and as to those matters he believes it to be true.

Roy E. Sweney.

Sworn to and subscribed before me this 20th day of May, 1930.

R. I. MacGeorge, Notary Public. (Notarial Seal.)
Notary Public, N. Y. Co. No. 573.
N. Y. Co. Reg. No. 1-M-734.
Bronx Co. Clerk No. 76.
Bronx Co. Reg. No. 3122-B.
Commission expires March 30, 1931.

[fol. 119] IN THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF MAINE, SOUTHERN DIVISION

In Equity

No. 927

UNITED STATES OF AMERICA, Plaintiff,

v.

MORKRUM COMPANY, Defendant

BILL OF COMPLAINT

To the Honorable Judge of the District Court of the United States for the District of Maine.

The United States of America brings this its bill of complaint against Morkrum Company, and for cause of action alleges:

I. This is a suit in equity brought by the United States of America as plaintiff.

II. As the plaintiff is informed and believes, the defendant Morkrum Company is a corporation organized under the laws of the State of Maine and an inhabitant of the State of Maine.

III. At all times hereinafter mentioned, the Bureau of Standards was and now is a subdivision of the Department of Commerce. The functions of said Bureau of Standards comprise the custody of standards; the comparison of the standards used with the standards adopted or recognized by the Government; the construction, the testing and the calibration of standards; and the conduct of scientific investigation, experimentation, studies and research in general.

[fol. 120] IV. At all times hereinafter mentioned the Bureau of Standards maintained and now maintains a radio section. The said radio section carries on calibration of various radio instruments, and conducts scientific investigation, experiments, studies and research in the radio field, and prepares and publishes scientific papers containing the results of its work for the purpose of disseminating knowledge to the parties interested therein and to the public generally. For the purpose of carrying on its work the said radio section maintains a radio laboratory.

V. As the plaintiff is informed and believes, one Francis W. Dunmore is a physicist and is trained in carrying on research and experimentation in various branches of physics and the science of electricity, including radio. From January 14, 1918, to date, the said Dunmore was employed in said radio section in the successive capacities of laboratory assistant and associate physicist. It was one of the duties of said Dunmore to carry on investigation, research and experimentation in such problems relating to radio and wireless as might be assigned to him by his superiors and to report the results thereof to his said superiors.

VI. In the course of his employment as aforesaid, there was assigned to said Dunmore by his superiors in said radio section, for investigation and research, the problem of

developing a radio receiving system operating a relay for the local or remote control of auxiliary apparatus.

VII. As the plaintiff is informed and believes, the said Dunmore pursuant to the aforesaid direction and instructions given him by his superiors proceeded to carry on studies, research, investigation and experimentation in said problem. The aforesaid work was done by said Dunmore at said radio laboratory of the Bureau of Standards with apparatus and materials which were the property of the plaintiff, and during his usual hours of employment. The aforesaid work was done by said Dunmore as one of the duties of his employment as aforesaid, and the results and product of said work is the property of the plaintiff.

VIII. Sometime prior to the 27th day of February, 1922, the said Dunmore solved the problem assigned to him by [fol. 121] his superiors as aforesaid and completed the said work hereinabove referred to by developing and inventing an apparatus known as a "radio relay". The aforesaid development and invention and all rights and interests therein are the property of the United States.

IX. As the plaintiff is informed and believes, the said Dunmore in disregard of his duties to the plaintiff and ignoring the rights of the plaintiff, and without the knowledge or approval of the plaintiff, filed in the United States Patent Office on February 27, 1922, an application for letters patent on said invention. Thereafter on July 5, 1927, letters patent of the United States numbered 1,635,117, and covering the said invention were issued to said Francis W. Dunmore on the basis of the said application.

X. The aforesaid letters patent are in equity and good conscience the property of the United States. Although the plaintiff demanded that the aforesaid letters patent be conveyed to the plaintiff, such demand has not been complied with.

XI. As the plaintiff is informed and believes the said Dunmore has unlawfully and illegally and in disregard of the plaintiff's rights purported to grant an exclusive license under the said letters patent to the defendant Morkrum Company, in so far as the device covered thereby may be used with printing telegraph apparatus; and to Dubilier Condenser Corporation, a corporation organized and exist-

ing under the laws of the State of Delaware, in so far as the said letters patent cover radio telephone broadcast receiving apparatus.

XII. As the plaintiff is informed and believes the defendant has at various times collected and received various sums of money from divers persons as royalties or license fees in connection with and arising out of said letters patent, which said moneys in equity and good conscience belong to the plaintiff and the said defendant holds the same in trust and for the benefit of the plaintiff.

XIII. The said Francis W. Dunmore and Dubilier Condenser Corporation are not made parties to this action be- [fol. 122] cause they are not within the jurisdiction of this court in that, as the plaintiff is informed and believes, the said Dunmore is an inhabitant of the District of Columbia and the said Dubilier Condenser Corporation is an inhabitant of the District of Delaware.

XIV. The plaintiff has no remedy at law.

Wherefore, the plaintiff prays this Honorable Court as follows:

1. That it be adjudged and decreed that the plaintiff is the owner of the invention hereinabove referred to and the defendant holds its interest therein as trustee and for the benefit of the plaintiff.

2. That it be adjudged and decreed that the plaintiff is the owner of letters patent of the United States numbered 1,635,117, and issued on July 5, 1927, and that the defendant holds its interest therein as trustee and for the benefit of the plaintiff.

3. That the defendant be directed and compelled to assign, transfer and convey to the plaintiff all its right, title and interest in and to the aforesaid invention and the aforesaid letters patent.

4. That the defendant be compelled and directed to account and pay over to the plaintiff all moneys received by it in connection with or arising out of the said invention and the said letters patent.

5. That the plaintiff have such other and further relief as to the court may seem just, together with the costs of this action.

6. That this Honorable Court issue its writ of subpoena in due form of law and according to the course and practice of this court directed to the said defendant Morkrum Company, commanding it at a certain date and under a certain penalty to be therein specified, to appear before this Honorable Court to answer all and singular the matters here- [fol. 123] inbefore set forth and complained of and to stand by and abide and perform all the orders and decrees of the court herein.

Charles B. Rugg, Assistant Attorney General. Alexander Holtzoff, Special Assistant to the Attorney General, of Counsel. Frederick R. Dyer, United States Attorney for the District of Maine.

[fol. 124] IN THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF MAINE, SOUTHERN DIVISION

In Equity

No. 927

UNITED STATES OF AMERICA, Plaintiff,

v.

MORKRUM COMPANY, Defendant

ANSWER

Now comes the defendant above named and answers plaintiff's bill of complaint as follows:

I. Defendant admits the allegations contained in paragraph I of the bill of complaint.

II. Defendant admits the allegations contained in paragraph II of the Bill of Complaint.

III. Defendant denies the allegations contained in paragraph III of plaintiff's bill of complaint.

IV. Answering paragraph IV of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

V. Answering paragraph V of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

VI. Answering paragraph VI of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither [fol. 125] admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

VII. Answering paragraph VII of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters alleged in the first two sentences therein, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may advise if the allegations in the said first two sentences of said paragraph VII are deemed material. The defendant denies each and every of the other allegations contained in said paragraph numbered VII.

VIII. Answering paragraph VIII of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters alleged in the first sentence therein, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may advise if the allegations in said sentence are deemed material. The defendant denies each and every of the other allegations contained in said paragraph numbered VIII.

IX. As to the matters alleged in paragraph IX of the bill of complaint, defendant admits that on February 27, 1922 one Francis W. Dunmore filed application for United States Letters Patent and secured thereon on July 5, 1927, Letters Patent of the United States Numbered 1,635,117. As to all other matters in paragraph IX the defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

X. Defendant denies each and every of the allegations contained in paragraph X of the bill of complaint, and defendant further alleges that no officer or agency of the United States Government was or is authorized to acquire the invention of the letters Patent 1,635,117 on behalf of the Government.

XI. Answering paragraph XI of the bill of complaint, defendant admits that a license was granted to it under [fol. 126] Letters Patent 1,635,117, but defendant has no knowledge of the grant of a license to Dubilier Condenser Corporation and therefore neither admits nor denies the same. Defendant denies each and every of the other allegations contained in the said paragraph XI.

XII. Answering paragraph XII of the bill of complaint, defendant denies each and every of the allegations contained therein.

XIII. Answering paragraph XIII of the bill of complaint, defendant says that it has no knowledge sufficient to form a belief of the matters therein alleged, and therefore neither admits nor denies the same but leaves the plaintiff to make such proof thereof as it may be advised if the allegations in said paragraph are deemed material.

XIV. Answering paragraph XIV of the plaintiff's bill of complaint, defendant denies the allegation contained therein.

Wherefore having duly answered the bill of complaint, this defendant denies that the plaintiff is entitled to the relief demanded or to any part of the same and prays that the bill of complaint be dismissed with costs.

Morkrum Company, by Sterling Morton, President.
Attest: Charles T. Pulham, Secretary. (Seal.)
McLeon, Fogg & Southard, Solicitors for Defendant. John B. Brady, of Counsel for Defendant.

[fols. 127-131] State of Illinois,
County of Cook, ss:

Sterling Morton, being duly sworn, deposes and says that he is President of Morkrum Company, the defendant in this suit, that he has read the foregoing Answer to the Bill of Complaint in this suit and knows the contents thereof, and that the same is true of his own knowledge ex-

cept as to the matters therein stated to be alleged upon information and belief, and as to those matters he believes it to be true.

Sterling Morton.

Sworn to and subscribed before me this 14th day of May, 1930.

Luther Victor Krause, Notary Public. (Seal.)

[fol. 132] EXHIBIT "C", ATTACHED TO PLAINTIFFS' AFFIDAVIT IN OPPOSITION TO THE MOTION TO DISMISS—Filed 13th June, 1934

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

To all to whom these presents come, Greeting:

UNITED STATES OF AMERICA,
District of Columbia, ss:

Be it remembered, that in the Supreme Court of the District of Columbia, at the City of Washington, in said District, at the times hereinafter mentioned, among others were the following proceedings, to wit:

Filed Jun. 8, 1933. Frank E. Cunningham, Clerk.

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

Equity No. 51,322

UNITED STATES

vs.

FRANCIS W. DUNMORE

MOTION TO DISMISS

Comes now the plaintiff, by its attorney, Lee A. Rover, United States Attorney in and for the District of Columbia, and moves the Court for permission to dismiss the above entitled cause, and states as a ground therefor that the matters involved in this suit have been adjudicated in another jurisdiction in such a manner as to preclude the

plaintiff from successfully prosecuting this cause of action.

Leo A. Rover, United States Attorney. John W. Fihelly, Assistant United States Attorney.

[fol. 133] Filed Jun. 8, 1933. Frank E. Cunningham, Clerk.

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

Equity No. 51,322

UNITED STATES

vs.

FRANCIS W. DUNMORE

ORDER OF DISMISSAL

Upon motion of the plaintiff's attorney, Leo A. Rover, United States Attorney in and for the District of Columbia, and it appearing to the court that the matters involved in the above entitled cause have been adjudicated in another jurisdiction in such manner as to preclude the plaintiff from successfully prosecuting this cause of action, and upon consent of counsel for the defendant, it is by the Court, this 8th day of June, 1933,

Ordered and decreed that the above entitled cause of action be and the same is hereby dismissed.

James M. Proctor, Justice.

I consent.

John B. Brady, Attorney for Defendant.

Filed Jun. 8, 1933 Frank E. Cunningham, Clerk.

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

Equity No. 51,323

UNITED STATES

vs.

FRANCIS W. DUNMORE

MOTION TO DISMISS

Comes now the plaintiff, by its attorney, Leo A. Rover, United States Attorney in and for the District of Colum-

[fol. 134] bia, and moves the Court for permission to dismiss the above entitled cause, and states as a ground therefor that the matters involved in this suit have been adjudicated in another jurisdiction in such a manner as to preclude the plaintiff from successfully prosecuting this cause of action.

Leo A. Rover, United States Attorney. John W. Fihelly, Assistant United States Attorney.

Filed Jun. 8, 1933. Frank E. Cunningham, Clerk.

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

Equity No. 51,323

UNITED STATES

vs.

FRANCIS W. DUNMORE

ORDER OF DISMISSAL

Upon motion of the plaintiff's attorney, Leo. A. Rover, United States Attorney in and for the District of Columbia, and it appearing to the court that the matters involved in the above entitled cause have been adjudicated in another jurisdiction in such manner as to preclude the plaintiff from successfully prosecuting this cause of action, and upon consent of counsel for the defendant, it is by the Court, this 8th day of June, 1933,

Ordered and decreed that the above entitled cause of action be and the same is hereby dismissed.

James M. Proctor, Justice.

I consent.

John B. Brady, Attorney for Defendant.

[fol. 135] Filed Jun. 8, 1933. Frank E. Cunningham, Clerk.

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

Equity No. 51,324

UNITED STATES

vs.

FRANCIS W. DUNMORE

MOTION TO DISMISS

Comes now the plaintiff, by its attorney, Leo A. Rover, United States Attorney in and for the District of Columbia and moves the Court for permission to dismiss the above entitled cause, and states as a ground therefor that the matters involved in this suit have been adjudicated in another jurisdiction in such a manner as to preclude the plaintiff from successfully prosecuting this cause of action.

Leo A. Rover, United States Attorney. John W. Fihelly, Assistant United States Attorney.

[fol. 136] Filed Oct. 23, 1933. Frank E. Cunningham, Clerk.

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 53,937

ALBERT S. BLATTERMAN, 1304 Wanamassa Drive, Asbury Park, N. J., Plaintiff,

vs.

PERCIVAL D. LOWELL, Airways Division, Department of Commerce, Washington, D. C.—FRANCIS W. DUNMORE, 3411 Rodman Street, N. W., Washington, D. C., Defendants

NOTICE

John B. Brady, Esq., Attorney for Lowell & Dunmore, Ouray Building, Washington, D. C.

DEAR SIR:

Please take notice that I have this day filed a Motion to Dismiss in the above entitled cause and copy thereof is hereby served upon you.

Respectfully, David P. Wolhaupter, Solicitor and Counsel for Plaintiff, 700 Tenth Street, N. W., Washington, D. C.

[fol. 137] Services of a copy of the foregoing Motion acknowledged this 23rd day of October, 1933.

John B. Brady, Attorney for Lowell & Dunmore.

Filed Jun. 8, 1933. Frank E. Cunningham, Clerk.

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

Equity No. 51,324

UNITED STATES

vs.

FRANCIS W. DUNMORE

ORDER OF DISMISSAL

Upon motion of the plaintiff's attorney, Leo A. Rover, United States Attorney in and for the District of Columbia, and it appearing to the court that the matters involved in the above entitled cause have been adjudicated in another jurisdiction in such manner as to preclude the plaintiff from successfully prosecuting this cause of action, and upon consent of counsel for the defendant, it is by the Court, this 8th day of June, 1933,

Ordered and decreed that the above entitled cause of action be and the same is hereby dismissed.

James M. Proctor, Justice.

I consent.

John B. Brady, Attorney for Defendant.

[fol. 138] Filed Oct. 23, 1933. Frank E. Cunningham, Clerk.

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 53,937

ALBERT S. BLATTERMAN, 1304 Wanamassa Drive, Asbury Park, N. J., Plaintiff,

vs.

PERCIVAL D. LOWELL, Airways Division, Department of Commerce, Washington, D. C.—FRANCIS W. DUNMORE, 3411 Rodman Street, N. W., Washington, D. C. Defendants

MOTION BY PLAINTIFF TO DISMISS BILL OF COMPLAINT

Now comes the plaintiff above named and respectfully represents to this Honorable Court that he has exhibited his bill against the defendants, Pervical D. Lowell and Francis W. Dunmore; that the said defendants have appeared thereto, but have not prayed for any affirmative relief, and will not be prejudiced in any substantial right by dismissal of the plaintiff's bill; and that the plaintiff is now advised to dismiss his said bill.

Wherefore, the plaintiff moves that the bill be dismissed out of this Court, without prejudice, and without costs against either party.

David P. Wolhaupter, Solicitor and Counsel for Plaintiff, 700 Tenth St., N. W., Washington, D. C.

Assented to.

John B. Brady, Solicitor and Counsel for Defendants.

[fol. 139] Filed Oct. 24, 1933. Frank E. Cunningham, Clerk.

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 53,937

ALBERT S. BLATTERMAN, 1304 Wanamassa Drive, Asbury Park, N. J., Plaintiff,

vs.

PERCIVAL D. LOWELL, Airways Division, Department of Commerce, Washington, D. C.—FRANCIS W. DUNMORE, 3411 Rodman Street, N. W., Washington, D. C. Defendants

ORDER

On motion of plaintiff, by his attorney, it is this 23rd day of October, 1933, ordered that this case be and the same is hereby dismissed without cost to any of the parties.

F. D. Letts, Judge, Supreme Court of the District of Columbia.

David P. Wolhaupter, Solicitor and Counsel for Plaintiff.

[fol. 140] Filed Oct. 23, 1933. Frank E. Cunningham, Clerk.

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 53,938

WIRED RADIO, INC., and ROBERT D. DUNCAN, JR., Plaintiffs,

vs.

PERCIVAL D. LOWELL, FRANCIS W. DUNMORE, ALBERT S. BLATTERMAN, and Westinghouse Electric & Manufacturing Company, Defendants

MOTION BY PLAINTIFFS TO DISMISS

Now comes the plaintiffs above named and respectfully represent to this Honorable Court that they have exhibited their bill against the defendants, Percival D. Lowell, Francis W. Dunmore, Albert S. Blatterman and Westinghouse

Electric & Manufacturing Company; that the said defendants have appeared thereto, but have not prayed for any affirmative relief, and will not be prejudiced in any substantial right by a dismissal of the plaintiff's bill, and that the plaintiffs are now advised to dismiss their said bill.

Wherefore the plaintiffs move that the said bill be dismissed out of this Court, without prejudice, and without costs against any party.

James F. Pierce, Solicitor and Counsel for Plaintiffs, 1319 F Street Northwest, Washington, D. C.

Dated October 19th, 1933.

[fol. 141] Filed Oct. 23, 1933. Frank E. Cunningham, Clerk.

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 53,938

WIRED RADIO, INC., and ROBERT D. DUNCAN, JR., Plaintiffs,

vs.

PERCIVAL D. LOWELL, FRANCIS W. DUNMORE, ALBERT S. BLATTERMAN, and Westinghouse Electric & Manufacturing Company, Defendants

NOTICE

John B. Brady, Esq., Ouray Building, Washington, D. C., Atty. for Lowell & Dunmore; Richard H. Wilmer, Esq., Transportation Bldg., Washington, D. C., Atty. for Westinghouse Electric & Mfg. Co.; David P. Wolhaupter, Esq., McLachlen Building, Washington, D. C., Atty. for Blatterman.

GENTLEMEN:

Please take notice that I have this day filed a Motion to Dismiss in the above-entitled cause and a copy thereof is hereby served upon you.

Respectfully, James F. Pierce, Counsel for Plaintiffs, 1319 F Street, N. W., Washington, D. C.

[fol. 142] Service of a copy of the foregoing Motion acknowledged this 23rd day of October, 1933.

John B. Brady, Atty. for Lowell & Dunmore. Richard H. Wilmer, Atty. for Westinghouse Electric & Mfg. Co. D. P. Wolhaupter, Atty. for Blatterman.

Filed Nov. 7, 1933. Frank E. Cunningham, Clerk.

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 53,938

WIRED RADIO, INC., and ROBERT D. DUNCAN, JR., Plaintiffs,

vs.

PERCIVAL D. LOWELL, FRANCIS W. DUNMORE, ALBERT S. BLATTERMAN, and Westinghouse Electric & Manufacturing Company, Defendants

ORDER

On motion of plaintiffs, by their attorney, it is this 7th day of November, 1933, ordered that this case be and the [fol. 143] same is hereby dismissed, without cost to any of the parties.

F. D. Letts, Justice, Supreme Court of the District of Columbia.

James F. Pierce,
Solicitor and Counsel for Plaintiffs.

Above order consented to by:

John B. Brady, Attorney for Lowell & Dunmore; Richard H. Wilmer, Attorney for Westinghouse Electric & Mf[illegible]o.; David P. Wolhaupter, Attorney for Blatterman.

AUTHENTICATION

Supreme Court of the District of Columbia:

I, Frank E. Cunningham, Clerk of the said Court, do hereby certify that the writings annexed to this certificate

are true copies of originals on file and of record in said Court in this cause.

Witness my hand and the seal of said Court, this 5th day of June, 1934.

Frank E. Cunningham, Clerk. (Seal.)

I, Alfred A. Wheat, Chief Justice of said Court, do hereby certify the foregoing attestation by Frank E. Cunningham, Clerk of the said Court, to be in due form.

Witness my hand and seal this 5th day of June, 1934.

Alfred A. Wheat, Chief Justice. (Seal.)

I, Frank E. Cunningham, Clerk of said Court, hereby certify that the Honorable Alfred A. Wheat, whose genuine [fol. 144] signature is subscribed to the foregoing certificate, was, at the time of signing and attesting the same, Chief Justice of said Court, duly commissioned and qualified.

Witness my hand and the seal of said Court, this 5th day of June, 1934.

Frank E. Cunningham, Clerk. (Seal.)

EXHIBIT "D", ATTACHED TO PLAINTIFF'S AFFIDAVIT IN OPPOSITION TO THE MOTION TO DISMISS—Filed 13th June, 1934

At a stated term of the United States District Court, held in and for the Eastern District of New York, at the Post Office Building, in the Borough of Brooklyn, City of New York, on the 3rd day of July, 1933.

Present: Honorable Robert A. Inch, District Judge.

E—4934

UNITED STATES OF AMERICA, Plaintiff,

against

PERCIVAL D. LOWELL, Defendant

Upon motion of plaintiff's attorney, Howard W. Ameli, United States Attorney in and for the Eastern District of New York, and upon the annexed stipulation dated June

27, 1933, and the letter from the Attorney General of the United States, dated June 6, 1933, a copy of which is annexed to said stipulation, and it appearing to the Court that the matters involved in the above entitled cause have been adjudicated in another jurisdiction in such manner as to preclude the plaintiff from successfully prosecuting this cause of action, and upon the subjoined consent of counsel for the defendant, it is

Ordered and decreed that the above entitled cause of action be and the same hereby is dismissed without costs to either party as against the other.

Robert A. Inch, United States District Judge.

[fol. 145] Entry of the foregoing order is hereby consented to and notice of the presentation thereof waived.

Raiemond E. Dee, Attorney for Defendant.

A true copy—Attest:

Percy W. B. Gilkes, Clerk, by S. R. Fener, Deputy Clerk. (Seal.)

Dated August 12th, 1933.

UNITED STATES DISTRICT COURT, EASTERN DISTRICT OF NEW YORK

E—4934

UNITED STATES OF AMERICA, Plaintiff,

against

PERCIVAL D. LOWELL, Defendant

It is hereby stipulated and agreed by and between the attorneys for the respective parties hereto, in accordance with letter of June 6, 1933, from the Department of Justice to the United States Attorney, a copy of which is hereunto annexed and made a part hereof, that the above entitled action be and the same hereby is, dismissed without costs to either party, and that an order in the form hereunto annexed, may be entered thereon without further notice.

Dated: Brooklyn, N. Y., June 27, 1933.

Howard W. Ameli, United States Attorney, Attorney for Plaintiff, by Albert D. Smith, Assistant United States Attorney. Raiemond E. Dee, Attorney for Plaintiff.

12—6689-C

[fol. 146] EXHIBIT "E", ATTACHED TO PLAINTIFF'S AFFIDAVIT IN OPPOSITION TO THE MOTION TO DISMISS—Filed 13th June, 1934

At a stated term of the United States District Court, held in and for the Eastern District of New York, at the Post Office Building, in the Borough of Brooklyn, City of New York, on the 3rd day of July, 1933.

Present: Honorable Robert A. Inch, District Judge.

E—4935

UNITED STATES OF AMERICA, Plaintiff,

against

PERCIVAL D. LOWELL, Defendant

Upon motion of the plaintiff's attorney, Howard W. Ameli, United States Attorney in and for the Eastern District of New York, and upon the annexed stipulation dated June 27, 1933, and the letter from the Attorney General of the United States, dated June 6, 1933, a copy of which is annexed to said stipulation, and it appearing to the Court that the matters involved in the above entitled cause have been adjudicated in another jurisdiction in such manner as to preclude the plaintiff from successfully prosecuting this cause of action, and upon the subjoined consent of counsel for the defendant, it is

Ordered and decreed that the above entitled cause of action be and the same hereby is dismissed without costs to either party as against the other.

Robert A. Inch, United States District Judge.

Entry of the foregoing order is hereby consented to and notice of the presentation thereof waived.

Raiemond E. Dee, Attorney for Defendant.

A true copy—Attest:

Percy W. B. Gilkes, Clerk, by S. R. Fener, Deputy Clerk. (Seal.)

Dated August 12th, 1933.

[fol. 147] UNITED STATES DISTRICT COURT, EASTERN DISTRICT OF NEW YORK

E—4935

UNITED STATES OF AMERICA, Plaintiff,

against

PERCIVAL D. LOWELL, Defendant

It is hereby stipulated and agreed by and between the attorneys for the respective parties hereto, in accordance with letter of June 6, 1933, from the Department of Justice to the United States Attorney, a copy of which is hereunto annexed and made a part hereof, that the above entitled action be, and the same hereby is, dismissed without costs to either party, and that an order in the form hereunto annexed, be entered thereon without further notice.

Dated: Brooklyn, N. Y., June 27, 1933.

Howard W. Ameli, United States Attorney, Attorney for Plaintiff, by Albert D. Smith, Assistant United States Attorney. Raiemond E. Dee, Attorney for Defendant.

[fol. 148] EXHIBIT "F", ATTACHED TO PLAINTIFF'S AFFIDAVIT IN OPPOSITION TO THE MOTION TO DISMISS—Filed 13th June, 1934

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 53938

WIRED RADIO, INC., Plaintiff,

vs.

PERCIVAL D. LOWELL ET AL., Defendant

The President of the United States to Francis W. Dunmore, 3411 Rodman, Defendant—Greeting:

You are hereby commanded to appear before the Supreme Court of the District of Columbia to answer a bill of com-

plaint (or petition) exhibited against you in the said Court in a suit in Equity by the above-named plaintiff, and to further do and receive what the said Court shall have considered in this behalf; and hereof fail not.

Witness the Honorable Chief Justice of said Court, the 23rd day of January, A. D. 1932.

Frank E. Cunningham, Clerk, by Harry W. Hull, Assistant Clerk. (Seal.)

——— ———, Attorney.

Note.—The defendant is required to file his answer or other defense in the Clerk's office on or before the twentieth day after service, excluding the day thereof; otherwise, the bill may be taken pro confesso.

[fol. 149] Supreme Court of the District of Columbia, Washington, D. C.

In Equity

No. 53938

Wired Radio, Inc., 60 Broadway, New York, N. Y., Robert D. Duncan, Jr., East Orange, New Jersey, Plaintiffs,

vs.

Percival D. Lowell, 8533—148th Street, Jamaica, New York; Francis W. Dunmore, 3411 Rodman Street, Washington, D. C.; Albert S. Blatterman, 1208 Wanamassa Drive, Asbury Park, New Jersey; Westinghouse Electric & Mfg. Co., East Pittsburgh, Pennsylvania

Bill of Complaint

To the Honorable Judges of this Court:

Plaintiffs state:

1. Wired Radio, Inc., a Delaware corporation having its principal place of business at 60 Broadway, City, County and State of New York, and Robert D. Duncan, Jr., a citizen of the United States, residing at East Orange, County of Essex, State of New Jersey, plaintiffs, bring this their Bill of Complaint against Percival D. Lowell, residing at 8533 148th Street, Jamaica, New York, and Francis W. Dunmore, residing at 3411 Rodman Street, Washington, D. C.,

Albert S. Blatterman, residing at 1208 Wanamassa Drive; [fol. 150] Asbury Park, New Jersey, and Westinghouse Electric and Manufacturing Company (assignee of Pupin), a Pennsylvania corporation having a place of business at East Pittsburgh, Pennsylvania.

2. This is a proceeding under the patent laws of the United States, Section 4915 of the Revised Statutes, U. S. Comp. Stat., Section 9460.

3. The plaintiffs have not appealed to the United States Court of Customs and Patent Appeals and no appeal is pending before said Court in this matter.

4. The question involved in this proceeding is that of priority of invention as between the interference parties in respect to claims 2, 20, 21 and 18 of U. S. Patent No. 1,455,141 to defendants, Lowell and Dunmore, granted May 15, 1923 on an application filed March 27, 1922. Claim 2 of said patent is the sole count of Patent Office Interference No. 53,154 involving the four (4) interference parties, Pupin, Duncan, Lowell and Dunmore, and Blatterman. Claims 20 and 21 of said patent are counts 1 and 2, respectively, of Interference No. 53,155 involving the two (2) interference parties, Duncan and Lowell and Dunmore. Claim 18 of said patent is an issue on which plaintiffs seek an award of priority de novo.

5. The invention involved in this proceeding is defined by claims 2, 20, 21 and 18 of said Lowell and Dunmore patent. Each of said claims is limited to apparatus for the reception of or for receiving radio signals, a source of alternating current for supplying power thereto and means for eliminating the hum of said alternating current. In addition; claim 2 specifies that the means for eliminating hum in the radio receiving apparatus be connected to the amplifying and rectifying means of the radio receiver, claim 20 specifies that the means eliminate hum in the reproducing means and be connected in circuit with said reproducing means, claim 21 specifies that the means serving to eliminate hum in the apparatus have fixed means in circuit with the grid and plate electrodes of the vacuum tubes and variable means in circuit with the grid electrodes, and claim 18 specifies that the means for eliminating hum be con-

nected in circuit with the grid and plate electrodes of the vacuum tubes.

[fol. 151] 6. The plaintiff, Robert D. Duncan, Jr., one of the interfering parties, and not the said Percival D. Lowell and Francis W. Dunmore, was the original, first and sole inventor of said invention described and claimed in said claims and in his annexed specification Serial No. 669,662; and said patent No. 1,455,141 to Lowell and Dunmore was improperly and inadvertently issued to the defendant Lowell and Dunmore.

7. The plaintiff Duncan conceived, explained said invention to others, constructed a full-size radio device embodying said invention and reduced said embodiment to practice by successful tests during April, 1921 and prior to May 7, 1921; and subsequently in May, 1923 commercially adopted said invention in commercial devices which embodied not only the arrangement of his April, 1921 device, but also the identical system of hum elimination that was embodied in said April, 1921, device.

8. The said tests were made at the Bureau of Standards in April, 1921 by the plaintiff Duncan and his assistant Samuel Isler and were prior to any date of conception of the invention alleged by the interference parties Lowell, et al., and Blatterman and were prior to the filing date of the interference party Pupin who filed his application for patent involved in Interference No. 53,154 only on February 4, 1924 and on whose behalf no priority testimony was taken and whose patent No. 1,571,456, filed December 31, 1915, upon which said Pupin relied, does not disclose the invention.

9. The plaintiff Duncan on or about October 20, 1923, his invention then having been proved commercially, filed an application for patent on said invention, Serial No. 669,662, said application having been made in all respects in strict and full accordance with the statutes of the United States and the rules of practice of the Patent Office relating to such applications. And he does not know and does not believe that the said invention was ever known or used by others in this country or patented or described in any printed publication in this or any foreign country prior to his invention or discovery thereof or more than two years

prior to his application for patent or patented in any foreign country on an application filed more than twelve months prior to the filing of the application for patent, or in public use or on sale in this country for more than [fol. 152] two years prior to said application, and that he has not abandoned the invention to the public.

10. The plaintiff Wired Radio, Inc. is the owner of the said Duncan application and invention.

11. After filing his application for patent, the plaintiff Duncan, through his attorney, became aware of the Lowell and Dunmore patent referred to, copied certain claims thereof and the two interferences heretofore referred to resulted involving said claims 2, 20 and 21 of said Lowell and Dunmore patent.

12. All of said interference parties took priority testimony except the junior party Pupin. The plaintiff Robert D. Duncan, Jr. in testimony taken on his behalf furnished proof establishing the facts alleged herein and complied in all respects with the provisions of law governing interference proceedings.

13. In both of said interferences priority of invention was awarded to the party Lowell and Dunmore by the Board of Appeals in its decisions, both of which are dated July 25, 1931. The Examiner of Interferences (page 4, line 10) accorded to Duncan the early part of April as his date of conception as to count 1 of interference No. 53,155 (claim 20 of said Lowell and Dunmore patent). The Board of Appeals did not disturb this finding.

14. On November 4, 1931, the plaintiff Duncan petitioned the Board of Appeals for reconsideration of its decisions in both interferences on the ground that certain matters of his evidence, including plaintiff's subsequent commercial adoption of the invention, although theretofore urged by him, had been completely overlooked inasmuch as all decisions of the Patent Office were silent on the status of plaintiff's subsequent commercial adoption of the invention and other material matters of Duncan's evidence.

15. On November 30, 1931, the Board of Appeals denied said petitions for rehearing, stating that the petitions were

not filed until after the time for appeal for its decisions to the Court of Customs and Patent Appeals had expired.

16. On December 11, 1931, the plaintiff Duncan repetitioned the Board of Appeals in both interferences on the [fol. 153] ground that the limit of appeal by statute since 1927 does not expire until six (6) months after the decision of the Board of Appeals, and that the issue had not been met on material matters of evidence theretofore urged by Duncan in connection with the status of Duncan's commercial adoption of the invention, which repetition was denied by the Board of Appeals on January 20, 1932.

Therefore, plaintiffs pray that the plaintiff Duncan be declared to be the first, true and original inventor of the invention herein set forth and involved in said interferences Nos. 53,154 and 53,155, and that plaintiff Duncan be adjudged as entitled according to law to receive a patent for his said invention as specified in the following claims, which are claims 2, 20, 21 and 18, respectively, of said Lowell and Dunmore Patent No. 1,455,141.

2. In an apparatus for the reception of radio signals the combination of a source of signal energy, means for amplifying said signals, means for rectifying said signals, a source of alternating current for supplying power to said amplifying means, and means connected to said amplifying and rectifying means for eliminating the hum of said alternating current in said apparatus.

20. In an apparatus for receiving radio signals the combination of a source of signal energy, means for amplifying said energy, means for rectifying said energy, means for reproducing said energy, a source of alternating current for supplying power to said amplifying means, and means connected in circuit with said reproducing means for eliminating the hum of said alternating current in the reproducing means.

21. In an apparatus for the reception of radio signals the combination of a source of signal energy, a plurality of vacuum tubes having grid, filament and plate electrodes, a source of alternating current for supplying power to said tubes, a detector for rectifying said signal energy, circuits interconnecting said electrodes and said detector, fixed means in circuit with said grid electrodes and said plate electrodes, and variable means in circuit with said grid elec-

trodes, all of said means serving to eliminate the hum of the alternating current in said apparatus.

[fol. 154] 18. In an apparatus for the reception of radio signals the combination of a source of signal energy, a plurality of vacuum tubes having grid, filament and plate electrodes, a detector, circuits interconnecting said electrodes and said detector, a source of alternating current for supplying power to said circuits, and means connected in circuit with said grid and plate electrodes for eliminating the hum of the alternating current in said apparatus.

And that plaintiffs have such other relief as equity may deem just.

Wired Radio, Inc., by C. W. Hough, President. Robert D. Duncan, Jr. Philip S. McLean, Counsel for Plaintiffs. James F. Pierce, 1319 F. Street N. W., Washington, D. C. Telephone Metropolitan 1147, of Counsel.

O'N:P.

[fol. 155] ANSWER OF DEFENDANTS LOWELL AND DUNMORE —Filed 13 June, 1934

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 53,938

WIRED RADIO, INC., 60 Broadway, New York, New York—ROBERT D. DUNCAN, JR., East Orange, New Jersey, Plaintiffs,

vs.

PERCIVAL D. LOWELL, 8533 148th Street Jamaica, New York —FRANCIS W. DUNMORE, 3411 Rodman Street, Washington, D. C.—ALBERT S. BLATTERMAN, 1208 Wanamassa Drive, Asbury Park, New Jersey—WESTINGHOUSE ELECTRIC & MFG. Co., East Pittsburgh, Pennsylvania

To the Honorable Judges of the Supreme Court of the District of Columbia:

Now come the defendants, Percival D. Lowell and Francis W. Dunmore, and answer plaintiffs' bill of complaint insofar as it is directed against them as follows:

1. Defendant Francis W. Dunmore admits that he is a resident of Washington, D. C. Defendant Percival D. Lowell denies that he is a resident of New York. Defendants are not informed, save by said bill of complaint, as to the remaining allegations of paragraph 1 of the bill of complaint and leave the plaintiffs to their proof thereof.

[fol. 156] 2. Defendants admit that the bill of complaint purports to state a cause of action arising under Section 4915 of the Revised Statutes of the United States.

3. Defendants admit the allegations contained in paragraph 3 of the bill of complaint.

4. These defendants deny the allegations of paragraph 4 of the bill of complaint except that they admit that claim 2 of United States Letters Patent 1,455,141 granted May 15, 1923, to these defendants is the sole count of Patent Office Interference No. 53,154 involving the four (4) interference parties Pupin, Duncan, Lowell and Dunmore, and Blatterman, and claims 20 and 21 of said patent are counts 1 and 2, respectively, of interference No. 53,155 involving the two (2) interference parties Duncan and Lowell and Dunmore.

5. These defendants deny the allegations of paragraph 5 of the bill of complaint and deny that the claims of said patent 1,455,141 are limited in any manner other than expressed in the claims and specification.

6. These defendants deny the allegations of paragraph 6 of the bill of complaint except that they admit that United States Letters Patent 1,455,141 were issued to these defendants Lowell and Dunmore.

7. Defendants deny each and every one of the allegations of numbered paragraph 7 of plaintiffs' bill of complaint.

8. Defendants deny the allegations of numbered paragraph 8 of plaintiffs' bill of complaint except that defendants admit that the party Michael I. Pupin filed his application on February 4, 1924, and took no priority testimony and that the Pupin patent 1,571,456, based on application filed December 31, 1915, upon which said Pupin relied for priority, does not disclose the invention.

9. Defendants admit the filing of an application for Letters patent in the United States Patent Office on Octo-

ber 20, 1923, by Robert D. Duncan, Jr., which was given a Serial No. 669,662, but defendants deny each and every other of the allegations in paragraph numbered 9 of plaintiff's bill of complaint.

10. Defendants deny the allegations of paragraph 10 and allege upon information and belief that the Duncan [fol. 157] application and invention is owned by others than Wired Radio, Inc., to wit, the Federal Telegraph Company, a corporation organized and existing under the laws of the State of California.

11. These defendants are not informed as to the allegations of paragraph 11 of the bill of complaint and leave plaintiffs to make proof thereof except that they admit that the interferences declared between said application of plaintiff Duncan and said patent of these defendants Lowell and Dunmore embraced claims 2, 20 and 21 of said patent.

12. Answering paragraph 12, defendants admit that all of the said interference parties took priority testimony except the junior party Pupin. Defendants deny all of the other allegations contained in paragraph 12 of the bill of complaint.

13. Answering paragraph 13, defendants admit that priority of invention was awarded to Lowell and Dunmore and allege that what the tribunals found is stated in their opinions profert of which is hereby made.

14. These defendants deny the allegations of paragraph 14 of the bill of complaint except that they admit plaintiff Duncan on or about November 4, 1931 filed petitions before the Board of Appeals for reconsideration of its decisions in both said interferences.

15. These defendants deny the allegations of paragraph 15 of the bill of complaint except that they admit that on or about November 30, 1931, the Board of Appeals denied said petitions for rehearing. Profert of the decisions of the Board of Appeals is hereby made.

16. These defendants deny the allegations of paragraph 16 of the bill of complaint except that they admit that on or about December 11, 1931, plaintiff Duncan filed petitions before the Board of Appeals in both said interfer-

ences and that the Board of Appeals denied said petitions on or about January 20, 1932. Profert of the decisions of the Board of Appeals is hereby made.

17. Further answering these defendants state upon information and belief that claim 18 of said patent 1,455,141 was upon motion of these defendants dissolved from the issue of interference proceedings No. 53,154 by a decision [fol. 158] of the Law Examiner of the United States Patent Office on or about July 2, 1926, and no appeal from said decision was filed by or on behalf of plaintiff Duncan.

18. Further answering defendants aver, upon information and belief, that if said Duncan ever conceived the invention or inventions expressed in the claims enumerated in the bill of complaint or any of them, which defendants deny, he, nevertheless, failed to use due diligence as required by law, or any diligence at all, in adapting or perfecting the same or in reducing the same to practice or in filing his aforesaid application for patent therefor; and that in fact, he never did adapt or perfect the same or reduce the same to practice and that said alleged invention or inventions amounted to nothing more than an unsuccessful experiment or experiments.

19. Further answering, defendants state, upon information and belief, that at the time of the filing of their application for Patent, Serial No. 547,111, on March 27, 1922, referred to in the bill of complaint, they were the original, first, and joint inventors of the invention therein set forth and were and are entitled to a patent therefor, and that the application was duly filed and complied in all respects with the requirements of law in such cases made and provided, and that subsequently proceedings were had thereon in the Patent Office in all respects in accordance with the procedure prescribed by law and Letters Patent 1,455,141, were duly and regularly issued May 15, 1923, to the defendants in accordance with the procedure prescribed by law.

20. That the defendants Percival D. Lowell and Francis W. Dunmore duly presented to the Commissioner of Patents full and sufficient proof establishing that they were the true, original and joint inventors of the subject matter of the interferences referred to in the bill of com-

plaint and that they made the said invention prior to any date of invention which can be established by the plaintiff Robert D. Duncan, Jr., or either of the applicants Michael I. Pupin or Albert S. Blatterman, the other parties to the interferences referred to in paragraph 4 of the bill of complaint.

21. That with respect to the counts of interferences 53,154 and 53,155, Lowell and Dunmore conceived the invention set forth in the said counts on or about the twenty-[fol. 159] eighth day of September, 1921; that on or about the seventh day of October, 1921, the first drawings of the invention were made; that on or about the seventh day of October, 1921 they first explained the invention to others; that on or about the seventh day of October, 1921 the first written description of the invention was made; that they first embodied their invention in a full size radio receiving apparatus which was completed on or about the seventh day of October, 1921; that on or about the seventh day of October, 1921, the said receiving apparatus was first successfully operated at Washington, in the District of Columbia, that they have since continued to use the invention and have manufactured devices embodying said invention in many thousands.

Wherefore defendants allege that the decision of the Board of Appeals of the United States Patent Office in awarding priority of invention to defendants, was right and that the plaintiff is not entitled to the relief prayed for in the bill, nor to any relief and defendants pray this Court that the bill of complaint be dismissed with costs.

Francis W. Dunmore, Percival D. Lowell, by John B. Brady, Solicitor for Defendants.

City of Washington,
District of Columbia, ss:

Francis W. Dunmore and Percival D. Lowell, being duly sworn, depose and say that they are the defendants in this suit, that they have read the foregoing answer to the bill of complaint in this suit and know the contents thereof and that the same is true to their own knowledge except as to the matters therein stated to be alleged upon information and belief and that as to those matters they believe it to be true.

Francis W. Dunmore. Percival D. Lowell.

Sworn to and subscribed before me this 29th day of February, 1932.

Mary M. Devlin, Notary Public, D. C.

[fol. 160] (Copy)

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 53937

ALBERT S. BLATTERMAN, Plaintiff,

vs.

PERCIVAL D. LOWELL et al., Defendants

The President of the United States to Francis W. Dunmore, 3411 Rodman Street, N. W., Washington, D. C., Defendant—*Greeting:*

You are hereby commanded to appear before the Supreme Court of the District of Columbia to answer a bill of complaint (or petition) exhibited against you in the said Court in a suit in Equity by the above-named plaintiff, and to further do and receive what the said Court shall have considered in this behalf; and hereof fail not.

Witness, the Honorable Chief Justice of said Court the 23rd day of Jan., A. D. 1932.

Frank E. Cunningham, Clerk, by H. B. Dertzbaugh, Assistant Clerk. (Seal.)

——— ———, Attorney.

Note.—The defendant is required to file his answer or other defense in the Clerk's office on or before the twentieth day after service, excluding the day thereof; otherwise, the bill may be taken pro confesso.

[fol. 161] IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 53937

Action under 4915 U. S. Revised Statutes

ALBERT S. BLATTERMAN, 1304 Wanamassa Drive, Asbury Park, New Jersey, Plaintiff,

vs.

PERCIVAL D. LOWELL and FRANCIS W. DUNMORE, Defendants

BILL OF COMPLAINT

For issuance of Letters Patent

To the Honorable Judges of the Supreme Court of the District of Columbia:

Albert S. Blatterman, a citizen of the United States, and a resident of Asbury Park, County of Monmouth, and State of New Jersey, and a citizen of said State, plaintiff, brings this, his bill of complaint against Percival D. Lowell and Francis W. Dunmore, joint patentees of United States Patent No. 1,455,141, issued May 15, 1923, said Percival D. Lowell and Francis W. Dunmore, defendants, being residents of the District of Columbia and whose post-office addresses are, respectively, Airways Division, Department of Commerce, Washington, D. C., and 3411 Rodman Street, N. W., Washington, D. C.

Plaintiff, for his cause of action, brings this bill of complaint and alleges:

(I) That this is a suit in equity brought under the patent laws of the United States and jurisdiction of this Court depends upon Section 4915 R. S., as amended by the Act of March 2, 1927, 44 Stat. L. 1335, and Section 52 of the Judicial Code, Act of March 3, 1927, 44 Stat. L. 1394.

(II) That heretofore, and before about November 28, 1921, the plaintiff, Albert S. Blatterman, was the true, original, first and sole inventor of certain new and useful im-

[fol. 162] provements in a System for Radio Frequency Amplification, not known or used by others in this country, before his invention or discovery thereof, nor patented nor described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than two years prior to his application and not in public use or on sale in this country for more than two years prior to his application, not abandoned, and not patented in any foreign country on an application filed by him or his legal representatives or assigns more than twelve months prior to his application in the United States, and that no application for patent on said improvement has been filed by him or his representatives or assigns in any country foreign to the United States.

(III) That being, as stated, the original, first, and sole inventor of the said invention and entitled to a patent therefor, the said Albert S. Blatterman on or about the 10th day of March, 1922, duly filed in the United States Patent Office an application for Letters Patent on said invention, said application complying in all respects with the requirements of the law in such cases made and provided. That said application was given a filing date of March 10, 1922, and Serial No. 542,525, and after the examination required by law and other due proceedings had, the Commissioner of Patents on or about July 10, 1924, adjudged that the invention described and claimed in the said application for Letters Patent in part interfered with certain other pending applications, namely, an application for patent of the defendants, Percival D. Lowell and Francis W. Dunmore, filed March 27, 1922, Serial No. 547,111 and patented on May 15, 1923, under No. 1,455,141; and an application of Michael I. Pupin, filed February 4, 1923, Serial No. 690,586, entitled Supply System for Vacuum Tubes; and an application of Robert D. Duncan, Jr., filed October 20, 1923, Serial No. 669,662, the subject matter being defined by the Commissioner of Patents in the following interferences:

Interference No. 51,204, Lowell and Dunmore v. Blatterman, on the following counts:

In an apparatus for the reception of radio signals, the combination of a source of signal energy, a plurality of vacuum tubes having grid, filament and plate electrodes, [fol. 163] a detector, circuits interconnecting said electrodes and said detector, a transformer having a primary

winding connected to a source of alternating current, secondary windings, a two electrode valve rectifier having a filament and a plate, connections between one of said secondary windings and the filament of said rectifier, connections between another of said secondary windings and said rectifier whereby direct current is supplied to the plate circuits of said vacuum tubes, another of said secondary windings connected to supply heating current to the filaments of said vacuum tubes and a capacity and resistance connected in said plate circuits for eliminating the hum of said alternating current in said apparatus.

In an apparatus for receiving radio signals the combination of a source of signal energy, means for amplifying said energy, means for rectifying said energy, a source of alternating current for supplying power to said amplifying means, means for rectifying said current, and a plurality of separate means connected in circuit with said rectifying means for smoothing out the rectified current and supplying power to said amplifying means.

In an apparatus for the reception of radio signals the combination of a source of signal energy, a plurality of vacuum tubes having grid, filament and plate electrodes, a detector, circuits interconnecting said electrodes and said detector, a source of alternating current for supplying power to said circuits, and means connected in circuit with said grid and plate electrodes for eliminating the hum of alternating current in said apparatus.

Interference No. 51,702, Pupin v. Lowell and Dunmore v. Blatterman, the issue comprising the following counts:

In an apparatus for receiving radio signals, the combination of a source of signal energy, means for amplifying said energy, means for rectifying said energy, and a source of alternating current for supplying power to said amplifying means, and a plurality of means in circuit with said amplifying means for eliminating the hum of said alternating current in said apparatus.

In an apparatus for receiving radio signals the combination of a source of signal energy, means for amplifying [fol. 164] said energy, means for rectifying said energy, a source of alternating current for supplying power to said amplifying means, means for rectifying said current and

a plurality of separate means connected in circuit with said rectifying means for smoothing out the rectified current and supplying power to said amplifying means.

Interference No. 53,154, Pupin v. Duncan v. Lowell and Dunmore v. Blatterman, involving the following count:

In an apparatus for the reception of radio signals the combination of a source of signal energy, means for amplifying said signals, means for rectifying said signals, a source of alternating current for supplying power to said amplifying means, and means connected to said amplifying and rectifying means for eliminating the hum of said alternating current in said apparatus.

(IV) That the plaintiff, Albert S. Blatterman is the owner of the entire right, title and interest in and to the invention shown and described in his application for patent, Serial No. 542,525, filed March 10, 1922.

(V) That the said plaintiff duly presented to the Commissioner of Patents, as required by law, full and sufficient proof establishing the fact that the said Albert S. Blatterman, as heretofore alleged, was the true, original, and first inventor of the improvements constituting the subject matter of said interferences and after due proceedings had, including the presentation of evidence by the other applicants involved in said interference, the Commissioner of Patents by the Examiner of Interferences denied priority of invention in the interference issues to the said Albert S. Blatterman, and awarded priority of invention in the aforesaid interferences to Lowell and Dunmore.

(VI) That thereupon an appeal was taken by the said Albert S. Blatterman from the decision of the Examiner of Interferences to the Board of Appeals of the United States Patent Office, and said Board of Appeals, after hearing the said appeal erroneously, as plaintiff submits, awarded priority of invention of the issues in said interferences to the Defendants, Percival D. Lowell and Francis W. Dunmore, and refused a patent to the plaintiff upon his application aforesaid, as will more fully and at large appear [fol. 165] from duly authenticated records in Courts to be produced of the said application of Albert S. Blatterman and of the aforesaid proceedings in the Patent Office.

Wherefore, the plaintiff brings this suit in equity under and in accordance with the provision of the aforesaid statute in such cases made and provided, and prays this Honorable Court:

(1) To adjudge and decree that the plaintiff, Albert S. Blatterman, is the true, original and first inventor of the subject matter of the said interferences, and is entitled to receive Letters Patent of the United States for such invention.

(2) To authorize and direct the Commissioner of Patents to issue a patent on the above designated application of Albert S. Blatterman including the subject matter of the said interferences.

(3) For costs and such other relief in the premises as the nature of the case and the equities flowing to the plaintiff may require.

Albert S. Blatterman. David P. Wolhaupter, 700-10 St. N. W., Washington, D. C. Counsel and Solicitor for Plaintiff.

STATE OF NEW JERSEY,
County of Monmouth, ss:

On January 22, 1932, at Asbury Park, New Jersey, before me, a notary public in and for the county and State aforesaid, personally appeared Albert S. Blatterman, who, being duly sworn, testified that he is the plaintiff named in the foregoing bill of complaint; that he signed the same in his own behalf; and that he has read the bill of complaint and the allegations thereof are believed to be true.

A. D. Courett, Notary Public of N. J. (Seal.)

[fol. 166] ANSWER—Filed 13 June, 1934

IN THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

In Equity

No. 53,937

Action Under 4915 U. S. Revised Statutes

ALBERT S. BLATTERMAN, Plaintiff,

vs.

PERCIVAL D. LOWELL and FRANCIS W. DUNMORE, Defendants

To the Honorable Judges of the Supreme Court of the District of Columbia:

Now come the defendants above named and answer plaintiff's bill of complaint as follows:

Defendants are not informed as to the allegations of the first paragraph of the bill of complaint and leave plaintiff to make proof thereof except that they admit that Percival D. Lowell and Francis W. Dunmore are joint patentees of U. S. Letters Patent No. 1,455,141, issued May 15, 1923, and that the said Percival D. Lowell is a resident of the District of Columbia and has a postoffice address at Airways Division, Department of Commerce, Washington, D. C., and Francis W. Dunmore is a resident of the District of Columbia and has a postoffice address at 3411 Rodman Street, N. W., Washington, D. C.

I. Defendants admit that the bill of complaint purports to state a cause of action arising under Section 4915 of the Revised Statutes of the United States.

II. Defendants deny the allegations of numbered paragraph (II) of the plaintiff's bill of complaint.

III. Defendants deny the allegations of paragraph III of the bill of complaint except that they admit that plaintiff on or about March 10, 1922, filed in the United States Patent Office an application for Letters Patent which was given Serial No. 542,525 and the Commissioner of Patents on or about July 10, 1924, declared an interference between said application and U. S. Letters Patent 1,455,141, issued to

[fol. 167] defendants on May 15, 1923, and an application of one Michael I. Pupin, filed on or about February 4, 1923, Serial No. 690,586 and an application of Robert D. Duncan, Jr., filed on or about October 20, 1923, serial No. 669,662 with respect to the subject matter as stated in the amended bill of complaint and said interference was designated by the Commissioner of Patents as Interference No. 61,204; and the Commissioner of Patents on or about November 14, 1924 declared a further interference between aforesaid application of plaintiff and aforesaid application of Pupin and aforesaid patent of defendants with respect to the subject matter as stated in the bill of complaint and said interference was designated by the Commissioner of Patents as Interference No. 51,702; and the Commissioner of Patents on or about December 8, 1925, declared a further interference between aforesaid application of plaintiff and aforesaid application of Pupin and aforesaid application of Robert D. Duncan, Jr., and aforesaid patent of defendants with respect to the subject matter as stated in the bill of complaint, and said interference was designated by the Commissioner of Patents as Interference No. 53,154.

IV. Defendants are not informed as to the allegations of paragraph (IV) of the bill of complaint and leave plaintiff to make proof thereof.

V. Defendants deny the allegations of paragraph (V) of the Bill of Complaint except that they admit that the Commissioner of Patents by the Examiner of Interferences after due proceedings had, including the presentation of priority testimony and evidence on behalf of each party except the said Pupin, denied priority of invention in the interference issues to the said Albert S. Blatterman and awarded priority of invention in the aforesaid interferences to Lowell and Dunmore as will more fully appear from the said decisions, profert of which is hereby made.

VI. Defendants deny the allegations of paragraph (VI) of the bill of complaint except that they admit that an appeal was taken by the said Albert S. Blatterman from the decision of the Examiner of Interferences to the Board of Appeals of the United States Patent Office and said Board of Appeals after hearing said appeal affirmed the decision of the Examiner of Interferences and awarded [fol. 168] priority of invention of the issues in said inter-

ferences to the defendants Percival D. Lowell and Francis W. Dunmore and refused a patent to the plaintiff for the subject matter of said interferences, as will more fully appear from the said decisions profert of which is hereby made.

VII. Further answering defendants aver, upon information and belief, that if said Albert S. Blatterman ever conceived the invention or inventions on the dates alleged, as expressed in the claims enumerated in the bill of complaint or any of them, which defendants deny, he, nevertheless, failed to use due diligence as required by law, or any diligence at all, in adapting or perfecting the same or in reducing the same to practice or in filing his aforesaid application for patent therefor. And that, in fact, he never did adapt or perfect the same or reduce the same to practice; and that said alleged invention or inventions amounted to nothing more than an unsuccessful experiment or experiments; and that said Albert S. Blatterman wholly abandoned the same; and that any and every alleged invention by said Albert S. Blatterman set forth in the bill of complaint was abandoned by him before his application for Letters Patent therefor.

VIII. Further answering, defendants state, upon information and belief that at the time of the filing of their application for patent, Serial No. 547,111 on March 27, 1922, referred to in paragraph (III) of the bill of complaint, they were the original, first and joint inventors of the invention therein set forth and were and are entitled to a patent therefor, and that the application was duly filed and complied in all respects with the requirements of law in such cases made and provided, and that subsequently proceedings were had thereon in the Patent Office in all respects in accordance with the procedure prescribed by law and Letters Patent 1,455,141 were duly and regularly issued May 15, 1923, to the defendants in accordance with the procedure prescribed by law.

IX. That the defendants Percival D. Lowell and Francis W. Dunmore duly presented to the Commissioner of Patents full and sufficient proof establishing that they were the true, original and joint inventors of the subject matter [fol. 169] of the interferences referred to in paragraph (III) of the bill of complaint and that they made the said

invention prior to any date of invention which can be established by the plaintiff Albert S. Blatterman, or either of the applicants Michael I. Pupin or Robert D. Duncan, Jr., the other parties to the interferences referred to in paragraph (III) of the bill.

X. That with respect to the count of interference No. 53,154, (claim 3 of patent 1,455,141) Pupin v. Duncan v. Lowell and Dunmore v. Blatterman; Count 2 of interference 51,702, (claim 1 of patent 1,455,141), Pupin v. Lowell and Dunmore v. Blatterman; Count 3 of interference 51,204 (claim 18 of patent 1,455,141), Lowell and Dunmore v. Blatterman; Lowell and Dunmore conceived the invention set forth in the said counts on or about the twenty-eighth day of September, 1921; that on or about the seventh day of October, 1921, the first drawings of the invention were made; that on or about the seventh day of October, 1921, they first explained the invention to others; that on or about the seventh day of October, 1921, the first written description of the invention was made; that they first embodied their invention in a full size radio receiving apparatus which was completed on or about the seventh day of October, 1921; that on or about the seventh day of October, 1921, the said receiving apparatus was first successfully operated at Washington in the District of Columbia; that they have since continued to use the invention and have manufactured devices embodying said invention in many thousands; that with respect to the remaining counts of interferences 51,204 and 51,702, set forth in the amended bill of complaint, Lowell and Dunmore conceived the invention set forth in counts 1 and 2 of interference 51,204 (claims 15 and 19 of patent 1,455,141) on or about the first day of October, 1921; that they conceived the invention set forth in count 1 of interference 51,702 (claim 16 of patent 1,455,141) on or about September 28, 1921; that with respect to counts 1 and 2 of interference 51,204 and count 1 of interference 51,702, they first made drawings of the invention on or about October 7, December 8, and December 10, 1921; that on or about December 8, 1921, the first written description of the invention was made; that on or about the seventh day of October, 1921, they first explained their invention to others; [fol. 170] that they first embodied their invention in a full size radio receiving apparatus which was completed on the tenth day of December, 1921; that on or about the tenth

day of December, 1921, the said radio receiving apparatus was first successfully operated at Washington, District of Columbia; that they have since continued to use the invention and have manufactured devices embodying said invention in many thousands.

Wherefore defendants allege that the decision of the Board of Appeals of the United States Patent Office in awarding priority to defendants was right and that the plaintiff is not entitled to the relief prayed for in the bill, nor to any relief and defendants pray this Court that the bill of complaint be dismissed with costs.

Francis W. Dunmore, Percival D. Lowell, by John B. Brady, Solicitor for Defendants.

City of Washington,
District of Columbia, ss:

Francis W. Dunmore and Percival D. Lowell, being duly sworn, depose and say that they are the defendants in this suit, that they have read the foregoing answer to the bill of complaint in this suit and know the contents thereof and that the same is true to their own knowledge except as to the matters therein stated to be alleged upon information and belief and that as to those matters they believe it to be true.

Francis W. Dunmore. Percival D. Lowell.

Sworn to and subscribed before me this 29th day of February, 1932.

Mary M. Devlin, Notary Public, D. C.

[fol. 171] Plaintiffs' Exhibit No. 4

Exclusive License Agreement

Memorandum of Agreement, made and entered into this 20th day of October, 1924, by and between Dubilier Condenser & Radio Corporation, a corporation of the State of Delaware, having a place of business at 48 West Fourth Street, City, County and State of New York, (hereinafter called Dubilier), and Francis W. Dunmore and Percival D. Lowell, whose address is c/o John B. Brady, Ouray Build-

ing, Washington, D. C., (hereinafter called the Inventors), witnesseth:

Whereas, the Inventors have made certain inventions relating to Electron Tube Radio Receiving Apparatus wherein circuits of the Electron Tubes are supplied from the ordinary house lighting current without the employment of primary or secondary batteries, for which they have obtained United States Letters Patent No. 1,455,141, dated May 15, 1923 and entitled Radio Receiving Apparatus; and

Whereas, Dubilier is desirous of acquiring an exclusive license to manufacture, use and sell the aforesaid invention, such modifications thereof and improvements thereon as the Inventors have heretofore made or may hereafter make, together with the right to control all future licenses that may be granted as hereinafter more fully set forth:

(X) Now, therefore, for and in consideration of the premises and the covenants hereinafter cited and to be faithfully performed, and the sum of Five Thousand ($5000.00) Dollars by Dubilier to the Inventors in hand paid as advance royalties, the receipt of which is hereby acknowledged, it is understood and agreed as follows:

1. The Inventors covenant that they are the sole and exclusive owner of the aforesaid invention, modifications and improvements thereof, and the patent covering the same, and that they have the full right to enter into this agreement, except for the following licenses, true copies of which are annexed hereto and form part hereof:

[fol. 172] (a) Non-exclusive, personal, non-transferable license to the Timmons Radio Products Company.

(b) Non-exclusive, personal, non-transferable license to the United States Government for Governmental purposes only.

2. The Inventors further reserve to themselves the right to grant the following licenses, it being understood and agreed, however, that the said licenses and each of them shall contain the following clause:

(Y) This license is granted and this agreement entered into with the express understanding that all fixed con-

densers used in the manufacture of apparatus under the aforesaid patent shall be purchased from Dubilier Condenser & Radio Corporation, 48 West Fourth Street, New York, and violation of this covenant will render this contract null and void and all rights granted by licensors to licensee shall be discontinued.

Each license shall also be granted only upon the payment of the initial sum mentioned below in the nature of advance royalty and with the royalty per device fixed, as stated:

(a) A non-exclusive, personal, non-transferable license to the Pathe Phonograph & Radio Corporation, upon the payment of One Thousand ($1000) Dollars advance royalty and a specific royalty of Fifty Cents (50c) per device.

(b) A non-exclusive, personal, non-transferable license limited to the use of the invention only in connection with time clock mechanisms to the International Time Recording Company upon payment of Five Hundred ($500) Dollars advance royalties and a specific royalty of One ($1.00) Dollar per device. Broadcasting reception expressly excluded.

(c) A non-exclusive, personal, non-transferable license to C. Brandes, Inc., upon payment of One Thousand ($1,000) Dollars advance royalties, and a specific royalty of Fifty Cents (50c) per device.

(d) A non-exclusive, personal, non-transferable license for use of the invention only in connection with wired wireless to Wired Radio, Inc., upon payment of One Thousand [fol. 173] ($1,000) Dollars advance royalty and a specific royalty of Fifty Cents (50c) per device. Regular Broadcasting reception expressly excluded.

3. The Inventors hereby covenant and agree that copies of the foregoing licenses shall be submitted to Dubilier before the execution thereof and if said licenses are entered into, the Inventors further covenant and agree that upon failure of their licensees to comply with the clause relating to the purchase by said licensees of condensers from Dubilier, that the Inventors will forthwith revoke said licenses unless the same are continued by written permission so to do to the Inventors from Dubilier.

4. It is mutually understood and agreed that should any licensee under the said patent No. 1,455,141 be sued, or threatened with suit under letters patent held by an adversary, that the Inventors and Dubilier each shall have the independent right to grant a free, non-exclusive license to such adversary in consideration of a similar license under said adversary's patent, or upon such other terms as the parties hereto mutually agree upon; it being expressly agreed, however, that each party shall keep the other fully informed in the matter, and that each shall safeguard the other, the intent and purpose of this covenant being to provide that all licensees shall be maintained immune from damages arising out of any attack for infringement insofar as the Inventors and Dubilier may be able to quiet said attack by licensing the adversary.

5. Subject to the foregoing licenses and rights, the Inventors hereby give and grant to Dubilier, its successors and assigns, the exclusive right to manufacture, use and sell and to grant to others the right to manufacture, use and sell the aforesaid invention and any and all modifications thereof and improvements thereon that they have heretofore made or may hereafter make throughout the United States, its territories and Dependencies, and covenant to grant to Dubilier, or its nominee or nominees, the exclusive right to manufacture, use and sell, and to grant to others the right to manufacture, use and sell said invention, modification and improvement in each and every foreign country where such invention or improvement, or both, may be covered by letters patent.

[fol. 174] 6. The Inventors, during the life of this agreement, shall promptly file and diligently prosecute at their own expense any reissue of said United States Letters Patent, as the said Inventors and Dubilier may agree are necessary and desirable to adequately protect the said invention. The Inventors will keep Dubilier informed respecting all proceedings in the United States Patent Office in connection with said reissue, interference or any other proceeding that may therein arise and to consult Dubilier before taking any action that may detrimentally affect its interests.

7. Dubilier shall bear the expense of filing and prosecuting any applications for letters patent upon the aforesaid

invention, modification and improvement, as it may elect to file in foreign countries and the expense of maintenance of all letters patent that may be granted upon such applications, and hereby agrees to give to the Inventors timely written notice as to all foreign countries in which it elects to file applications for letters patent.

8. The Inventors shall execute all papers that may be necessary or desirable to enable Dubilier, or its nominee or nominees, to file and prosecute applications for letters patent in all countries in which Dubilier shall elect to secure patent protection for said invention, and to prosecute all suits thereunder.

9. Dubilier covenants to pay to the Inventors during the life of this agreement the following royalties:

(A) Fifty Cents per apparatus or device, until a total of Five Thousand ($5000) Dollars has been credited by the Inventors to Dubilier, this covering the Five Thousand ($5000) Dollars advance royalty paid as consideration for the making of this agreement (paragraph X, page 1 hereof).

(B) Fifty Cents per apparatus or device, until a total of Ten Thousand ($10,000) Dollars has been paid.

(C) On the next succeeding 60,000 devices, a royalty of twenty-five cents (25c) each.

(D) On the next succeeding 100,000 devices, a royalty of twenty cents (20c) each.

(E) On the next succeeding 200,000 devices, a royalty of fifteen cents (15c) each.

[fol. 175] (F) On all devices thereafter, a royalty of ten cents (10c) each.

10. Dubilier further covenants to pay to the Inventors any sum or sums of money that may accrue to Dubilier from any license hereafter granted by Dubilier in accordance with the provisions of this agreement, said sum to apply on the Ten Thousand ($10,000) Dollars payment specified in paragraph 9 B above. At any time the payment of said Ten Thousand ($10,000) Dollars is liquidated by Dubilier by monies accruing from sub-licensees or otherwise, then the royalty of fifty cents (50c) per device mentioned in said paragraph 9 B, shall be discontinued and the royalties there-

after accruing to Dubilier from licensees shall be divided as provided in paragraph 22 hereof.

11. Should this agreement be terminated for any cause whatsoever prior to the expiration of the patent mentioned herein, Dubilier covenants and agrees to assign to said Inventors any and all outstanding licenses it may have granted hereunder, and shall not thereafter be liable to said Inventors for any royalties due by said licenses after the date of said assignment.

12. For the purpose of determining the amount of royalties, the terms "apparatus" and "device" used herein are understood to refer to and include the following:

(a) A device for supplying filament current to radio receiving sets, replacing the usual A battery.

(b) A device for supplying plate current to radio receiving sets, replacing the usual B battery.

(c) A combination device for supplying both A and B battery for radio receiving sets.

(d) Apparatus embodying either (a), (b), or (c).

13. Only one royalty payment shall be made on account of a single complete apparatus or device and Dubilier shall not be liable for royalties upon any apparatus returned by purchasers for credit and shall have the right to deduct the amount of any such royalties already paid from the amount of the royalties that may subsequently accrue. No royalty shall be paid on the parts of apparatus that are sold as repairs or furnished as replacements.

[fol. 176] 14. In case the royalties accruing to the Inventors upon apparatus or devices manufactured and sold or used by Dubilier and its nominees or licensees during any calendar year of the life of this agreement shall not amount to Five Thousand ($5000) Dollars, or in case Dubilier otherwise fails to perform any of its obligations herein prescribed, the Inventors shall have the right upon sixty days' written notice by registered mail delivered to Dubilier, to terminate this agreement, it being understood that Dubilier shall be liable for all royalties that may have accrued prior to the date of actual termination of the agreement. However, if the said notice is given because the roy-

alties accrued and paid do not amount to the above specified sum, Dubilier may after receipt of such notice continue this agreement in full force and effect by making good the deficiency prior to the expiration of the said period of sixty days.

15. Dubilier covenants to pay the royalties due under this agreement to the Inventors in semi-annual payments on June thirtieth and January thirtieth, the said payments to include all royalties due and payable up to within thirty days of the said dates.

16. Dubilier shall keep and shall require its nominees and licensees to keep proper books of account with reference to all apparatus which it or they may manufacture and sell, embodying the aforesaid invention, modifications and improvements and shall render semi-annual statements or extracts from said books to the Inventors showing the total amount of such apparatus as may have been manufactured and sold during the preceding royalty period and the amount of royalties payable to the Inventors, the said statements to be rendered at the time of making the royalty payments designated in paragraph 15 hereof. Dubilier shall, when requested by the Inventors so to do, verify the said statements by affidavits and shall also permit and require its nominees and licensees to permit the Inventors, through a certified public accountant, to inspect such books of account and to make extracts therefrom at reasonable times, said accountant to be paid by the Inventor.

17. Dubilier shall use every reasonable endeavor to mark and to have its nominees and licensees mark all apparatus covered by the aforesaid patent and any others that may come within the scope of this agreement which is manu- [fol. 177] factured and sold by it or them with the dates thereof.

18. The Inventors hereby agree, subject to the direction and approval of Dubilier, to conduct such proceedings as may be considered necessary and desirable to enforce the said United States Letters Patent against alleged infringers and for this purpose, it is mutually agreed that John B. Brady, Esq., of Washington, D. C., shall be appointed a trustee to receive a trust fund consisting of ten per cent (10%) of all monies received by the said Inventors from

all sources arising out of the licensing of said United States Letters Patent, which they hereby agree to pay into said Brady, the same to be used as a fund for the legal expenses incident to the defense of suits that may be brought by others against Dubilier or the Inventors, or both of them, or their respective licensees, and also for the purpose of paying the necessary and proper legal expenses incident to the prosecution of infringers of the said patents it being understood that all expenses shall be paid out of the said fund and in the event that the said fund is insufficient, then the Inventor and Dubilier shall divide the said expenses equally between them provided they mutually so consent to do.

It is also mutually understood and agreed that when the said trust fund shall total the sum of Five Thousand ($5000) Dollars that payments into the same may be discontinued, to be resumed when necessary to re-establish the aforesaid account.

It is further mutually understood and agreed that the said trust fund may at any time be used for any purpose mutually agreed upon by the parties hereto.

19. The Inventors hereby give and grant to Dubilier the right to sue in its own name and at its own expense any infringers of said patent or patents and to collect for its own use and behoof such damages and profits as may be assessed as the result of such suit or suits, provided, however, that in all cases where the Inventors wish to join in any suit or suits they shall have the right so to do, in which event the expenses shall be paid out of said trust fund and Dubilier and the Inventors shall then share equally in the division of all monies received, as damages or profits that may be collected.

[fol. 178] 20. The Inventors hereby specifically grant to Dubilier the right to grant sub-licenses to others under the aforesaid patent, or any other patents that may come within the scope of this agreement, it being understood that Dubilier shall have the right to insert in said licenses, if it so desires, a paragraph similar to that of paragraph 2Y hereof, requiring use by the licensee of Dubilier condensers.

(a) It is also agreed that Dubilier shall have the right to include the total number of devices made by Dubilier

licensees, with the total number of devices made by Dubilier, in computing the total number of devices for the purpose of making royalty payments thereon, as specified in paragraph 9 hereof.

21. Dubilier hereby covenants and agrees to pay to the Inventors one-half of all sums received from any license that may be granted by Dubilier, it being mutually understood and agreed that the Inventors shall pay into the trust fund, paragraph 18 above, ten percent of all such money received from Dubilier as well as ten percent of all monies received from Dubilier as royalties from the manufacture and/or sale of apparatus.

22. Dubilier hereby covenants and agrees to pay into the trust fund as set forth in paragraph 18 hereof, ten percent of all monies received from sub-licensees, the following procedure being mutually agreed upon in this connection:

(a) Dubilier or its nominees shall collect royalties due under all licenses granted by Dubilier.

(b) The said royalties so collected shall be divided equally between Dubilier and the Inventors.

(c) Dubilier shall pay ten percent of the amount received to the trust fund, paragraph 18 hereof.

(d) The Inventors shall pay ten percent to the trust fund, paragraph 18 hereof.

23. If, as a result of court decisions substantial protection for the main subject-matter of this agreement is not afforded by said patent or if adversely held patents are declared to prevent manufacture of devices under said patent, Dubilier may terminate this agreement if it shall so elect.

[fol. 179] 24. In case of the termination of this agreement, for any cause whatsoever, all rights and obligations of the parties hereunder shall cease and their original rights of prosecution and defense of infringement suits shall be restored.

25. If any controversy shall arise between the parties as to the performance of any obligation under this agreement, the matter in controversy shall be submitted, at the

option of either party, to three arbitrators who shall have power to decide the matter in controversy, and to determine what, if any, amount shall be paid by either party to the other as liquidated damages for any breach of this agreement, and each party agrees to pay to the other any damages that may be assessed by the arbitrators. Upon such contingency, each party shall designate one arbitrator, and these two shall appoint a third a-bitrator. The expense of the arbitration shall be borne by the losing party or apportioned between the parties as the arbitrators may direct.

26. This agreement and the covenants herein contained shall be binding upon, and inure to the benefit of, the heirs, executors, administrators, successors and assigns of the parties hereto.

27. Dubilier agrees under this license not to enter into the manufacture of apparatus of this invention within an area of ten miles of Philadelphia and agrees further not to grant licenses to others engaging in such manufacture in said area without the consent of the inventors.

In witness whereof, Dubilier has caused these presents to be signed by its proper officer, and the Inventors have hereunto set their hands and seals the day and year first above written.

Dubilier Condenser & Radio Corp., by H. R. Van Deventer, Vice President. Attest: M. A. Howard, Secy. (Seal.). Percival D. Lowell. (Seal.) Francis W. Dunmore. (Seal.)

Witness: Ralph R. Batcher.
Witness: J. Harold Morgan.

[fol. 180] Non-exclusive License Agreement

This Agreement, made this first day of August, 1924, by and between Percival D. Lowell and Francis W. Dunmore, of Washington, District of Columbia, parties of the first part and Timmons Radio Products Corporation, a corporation of Pennsylvania, having its principal place of business at Philadelphia, party of second part, Witnesseth:

Whereas parties of the first part are the owners of certain and useful improvements in radio receiving apparatus

for operation of such apparatus without batteries from the alternating current lighting source in the home covered by Letters Patent 1,455,141, dated May 15, 1923, and warrant that they are the sole owners thereof; and

Whereas parties of the first part are the owners of certain new and useful improvements in radio receiving apparatus for operation of such apparatus without batteries from the alternating current lighting source in the home covered by Letters Patent 1,455,141, dated May 15, 1923, and warrant that they are the sole owners thereof; and

Whereas party of the second part has facilities for the manufacture, sale and distribution of apparatus embodying said invention and is desirous of securing a non-exclusive license in and to said patent;

Now, therefore, in consideration of the payment by party of the second part to parties of the first part of the sum of One Thousand ($1000) Dollars, to be credited on account as advance royalties, upon the execution of this agreement, the parties have agreed as follows:

First. Parties of the first part hereby grant to party of the second part a non-exclusive license under said patent, to manufacture or have manufactured, and to sell apparatus embodying said invention, said license to continue during the full term of said Letters Patent, unless and until terminated as hereinafter provided.

Second. Party of the second part agrees to pay to the parties of the first part a royalty of Fifty (50c) Cents on each apparatus unit embodying the said invention manu- [fol. 181] factured and sold by party of the second part. An apparatus unit shall be a device dispensing with the A battery, a device dispensing with the B battery, or a single combined apparatus dispensing with both or all batteries.

Third. Party of the second part further agrees that in order to maintain this license that said royalties shall equal a minimum of One Thousand ($1000) Dollars per year, July 1 to June 30, and if not paid without notice within 30 days after June 30th of any year, this license shall automatically terminate. It is further agreed that in the event that party of the second part is prevented by legal process or otherwise from manufacturing, selling

and distributing the said apparatus, that notice shall be served upon parties of the first part and party of the second part shall thereupon be relieved of the payment of royalties, but such notice shall not operate to relieve party of the second part from the payment of royalties shown to be due at the time of such notice. It is understood that the agreement may be renewed under the same terms at the option of party of the second part whenever such circumstance have been overcome.

Fourth. Parties of the first part agree that in order to protect party of the second part against unreasonable competition occasioned by the attraction of skilled employees by competing manufacturers within an area of ten miles of Philadelphia that no additional licenses shall be granted in said area without the consent of party of the second part. Parties of the first part further agree to protect party of the second part from interference by other patent holders to the extent of standing ready to license such other patent holders under the aforementioned patent in consideration of the licensing of the party of the second part by such other patent holders under such other patents without further expense to the party of the second part. Parties of the first part agree that in the event that the above mentioned patent be declared invalid by a court of final and competent jurisdiction that payment of royalties under this agreement shall be discontinued.

Fifth. Party of the second part agrees to mark literature or apparatus sold under the said patent distinctively with a notice agreeable to both parties in accordance with the following suggestions:

[fol. 182] Licensed Under United States Patent 1,455,141
Dated May 15, 1923

or

Patented 5-15-23—Other Patents Pending

Sixth. Party of the second part agrees to maintain books of account open at all convenient times to the inspection of parties of the first part showing all apparatus units embodying the said invention manufactured and sold and render a report to parties of the first part every six months within Thirty days following June 30th and December 31st,

showing the number of apparatus units Manufactured and sold for the proceeding six months accompanied by payment of royalties shown then to be due.

Payments made, or notices given to P. D. Lowell, care of John B. Brady, Ouray Building, Washington, D. C., or addressed to his last known post office address shall be deemed for all purposes of this agreement made or given to the parties of the first part.

This license shall not be transferable without the consent of the parties of the first part, except to the successor or successors to the business of said Timmons Radio Products Corporation.

In witness whereon, Percival D. Lowell and Francis W. Dunmore, have signed this instrument and the Timmons Radio Products Corporation has caused this instrument to be executed by its officers thereunto duly authorized (Done in triplicate).

Percival D. Lowell. Francis W. Dunmore. Witness: William F. Diehl. Witness: Corinee D. Dunmore. Timmons Radio Products Corporation, by J. S. Timmons, President. Attest: J. McL. Timmons, Secretary.

Pltfs x 7 PLAINTIFFS' EXHIBIT No. 7, Sheet 1. (Dubilier catalogue describing Super-Ducon.) 183—184

The Super-Ducon

and how to install it • •

Eliminating all "B" batteries

A DEVICE of this sort, bettering reception, lowering the cost and improving the appearance of radio sets, has been the object of radio engineers for many years. Though special methods have been employed from time to time, using house current to replace "B" batteries for special circuits, the SUPER-DUCON is a tremendous achievement, because it is the first successful device to make house current available for *any* vacuum tube set! And it is significant that it should be the achievement of DUBILIER engineers, famous as pioneers in the development of fixed condensers.

Dubilier

Keep your set always at its best

You want your set to be working at its best when unexpected guests drop in. Perhaps you have been telling them what a wonderful set it is—but if the "B" batteries are low, it will mean disappointment to your friends and apologies from you.

With a DUBILIER SUPER-DUCON your set is always ready to give you sufficient and dependable volume. Attached to your light socket it never fails.

Constant "B" Voltage-- Always

Unlike "B" batteries, the SUPER-DUCON cannot run down. Turn the electric switch and immediately a smooth, silent "B" voltage flows to your receiver. The SUPER-DUCON requires no attention. Year in, year out, it will continue to furnish this perfect "B" power to your set.

Clearer Reception

"B" batteries when partially run down often cause crackling noises which interfere with clear reception. Clearer reception always results from the use of the SUPER-DUCON because it is noiseless.

The detector tube in most receiving sets is somewhat critical of adjustment—but a turn of the regulating knob on the SUPER-DUCON immediately varies the detector tube "B" voltage from 10 to 50 volts, giving purest tone and clearest reception.

PLAINTIFFS' EXHIBIT NO. 7, Sheet 2.
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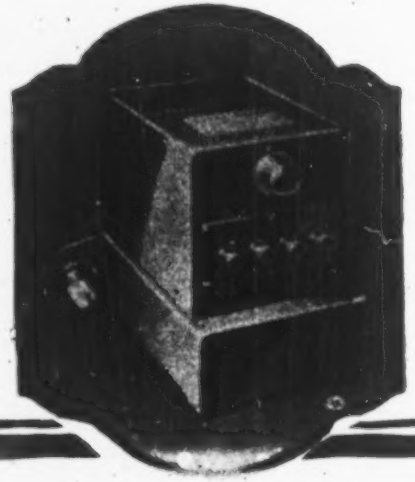
You don't need "B" Batteries

Power from the house lighting current, with its many advantages, has rapidly become the most practical form of "B" voltage supply.

The SUPER-DUCON always delivers a smooth, steady flow of current to your radio set and is second to none of the "B" battery eliminators now on sale. Through the concentrated efforts of our engineers and the use of only the finest quality materials, we are now producing a "B" battery eliminator which is entirely free from any power line noises.

The success of any eliminator depends almost entirely upon its condensers, for they alone make possible the filtering of the fluctuating A.C. house current into the unwavering, constant D.C. flow imperative for the successful operation of a radio set.



It is again significant that DUBILIER, the recognized authority on and known the world over for their condensers, should lead the field with the SUPER-DUCON.

The Rectifier Tube

The rectifier tube, second only to the filter condensers in importance, must be of extremely rugged construction both electrically and mechanically and should have an average life of at least six to eight hundred hours.

Because of its special construction, the Rectron UV-196, employed in the SUPER-DUCON, is exceptionally rugged and consequently it posesses those lasting qualities so necessary for the successful operation of a "B" battery eliminator. With its average life of one thousand hours or more the UV-196 should give satisfactory service for approximately one year. It is designed to accomplish full wave rectification, and therefore has two separate filaments. These are of the ribbon, oxide coated type, for a thorough investigation has proven their leadership over other forms of filament.

The design of this special rectifier tube is the result of intensive research in the DUBILIER laboratories and after collaboration with the engineers of the Westinghouse Electric & Manufacturing Company it is now manufactured by the latter for the Dubilier SUPER-DUCON.

PLAINTIFFS' EXHIBIT NO. 7, SHEET 3. 187—188

eat – Compact

Since radio has come down from the attic to a prominent place in the living room, it is important that accessories should be as neat and compact as possible, and not detract from the appearance of the room. Untidy "B" batteries, with their unsightly wires, must be concealed in some way in order to preserve the orderly appearance so desirable to any housewife.

The SUPER-DUCON is just 9¾ inches long, 8 inches high and 5½ inches wide—smaller than the average 80 ampere storage battery. Its enameled metal case is finished in a pleasing shade of dark green. The small size of the SUPER-DUCON makes it inconspicuous—its finish harmonizes with all surroundings.

The SUPER-DUCON is smaller than four standard 22½ volt "B" batteries of the dry cell type. The accompanying photograph gives some idea of its small size.

Cutting the cost of Radio

When you install a SUPER-DUCON there will be no more recharging or replacing of expensive "B" batteries.

There are no moving parts to wear out in the SUPER-DUCON. The rectifying element, with its average life of one thousand or more hours, may, like any ordinary incandescent lamp or radio tube, give out in time. It may, however, be replaced through any DUBILIER dealer for a nominal sum.

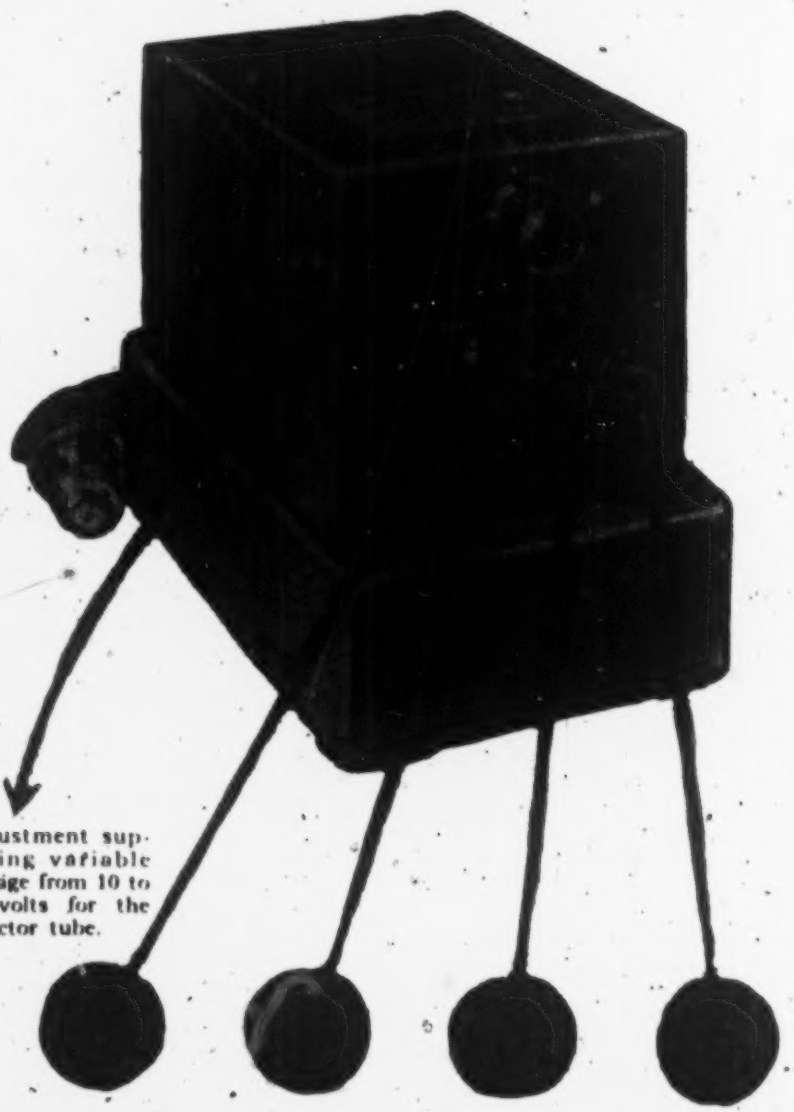
This chart shows the maximum power consumption of the SUPER-DUCON as compared with familiar household electrical appliances.

No matter how long the SUPER-DUCON is permitted to stand idle it does not depreciate.

PLAINTIFFS' EXHIBIT NO. 7, Sheet 4.

189-1

How to connect the SUPER-DUCON



Adjustment supplying variable voltage from 10 to 50 volts for the detector tube.

Alternating Current, Type 800-A

1 −B BAT. Connect this terminal to the −B binding post on your radio set.

2 +B DET. Connect this terminal to the + B detector binding post of your set. This supplies a "B" potential of 10 to 50 volts to your detector tube, controlled by turning the regulating knob of the SUPER-DUCON. Turned clockwise voltage is increased — counterclockwise it is reduced. This adjustment gives you exactly the voltage your particular type of detector tube requires. Regulate it for the best results.

3 +B AMP. Connect this terminal to the + B amplifier binding post of your set. It supplies the amplifier voltage.

4 +B AMP. This is a separate "B" voltage tap for audio frequency amplifiers and is especially adapted for use with the new UX Radiotrons.

NOTE On ungrounded loop sets the — B terminal of the Super-Ducon must be grounded.

SUPER-DUCON for Alternating Current $47.50

INCLUDING THE NEW RCA TUBE UV 199

PLAINTIFF'S EXHIBIT No. 7 sheet 5

191-192

To get the best results

THE picture diagram and explanations, given on pages 8 and 9 of this booklet, adequately describe the connections on the SUPER-DUCON. We suggest, however, that you carefully read the following pages before installing the machine.

The new SUPER-DUCON has four "B" battery binding posts as may be seen from the cut on page 8.

On receivers having four "B" battery terminals use all posts on SUPER-DUCON as in diagram No. 1.

When connecting the SUPER-DUCON to radio sets having but three "B" battery terminals, ignore the last "B Amp." post on the SUPER-DUCON and connect as shown in diagram No. 2.

If a radio set calls for but two "B" terminals connect the SUPER-DUCON as in diagram No. 3.

If you have a loop set or a receiver in which the "A" Battery is not grounded through a connection within the receiver itself it will then be necessary to put an additional ground wire to the —B post on the SUPER-DUCON. CAUTION: DO NOT USE THIS CONNECTION UNLESS YOU ARE SURE THE "A" BATTERY IS NOT GROUNDED.

On the last pages of this booklet you will find a chart of some well known makes of radio receivers. If your receiver is listed among them it is only necessary to refer to the diagram recommended. The fourth column marked "GROUND NOTE" shows whether or not a ground wire should be connected to the —B terminal on the SUPER-DUCON to obtain best results.

WHEN installing the SUPER-DUCON, care should be taken to keep it at least two feet from the receiver itself. This will not be found difficult in most cases. If it is desired to place the SUPER-DUCON in the cabinet of the radio set, keep it as far from the audio frequency end of the set as possible. Do not allow the SUPER-DUCON cord to become coiled up near any portion of the receiver or the antenna lead-in.

Reducing Output Voltage of the Super-Ducon

If the output voltage of the SUPER-DUCON is greater than required, a variable resistance of from five thousand to ten thousand ohms may be used as shown in diagram No. 4. This resistance, when connected across the output terminals allows a voltage regulation of from forty or fifty volts to maximum. When the SUPER-DUCON is used with the Radiola Super-Heterodyne or similar receivers using dry cell tubes we recommend this connection.

Important

In some localities reception may be improved by entirely removing the ground wire from the receiver and connecting it to the —B binding post on the SUPER-DUCON.

PLAINTIFFS' EXHIBIT No. 7 sheet 6
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194

The SUPER-DUCON and your receiver

Diagram No. 1

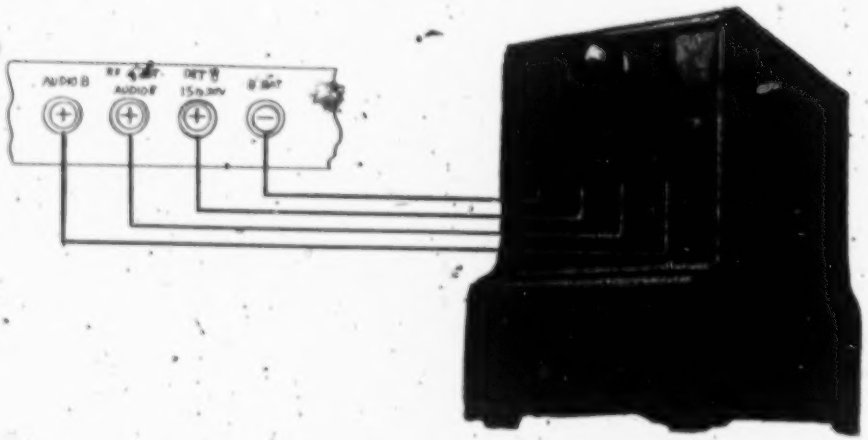


Diagram No. 2

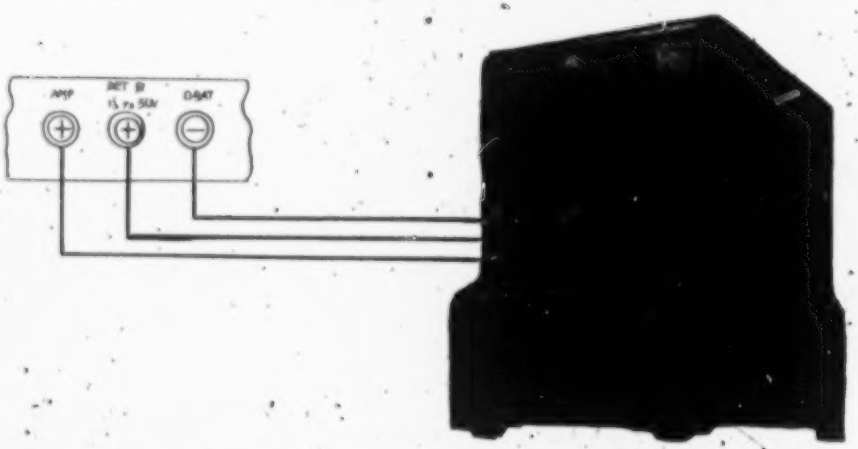


Diagram No. 3

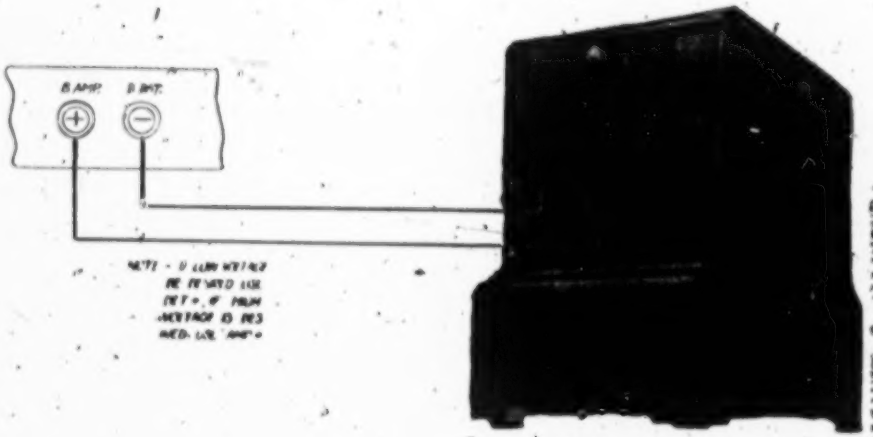
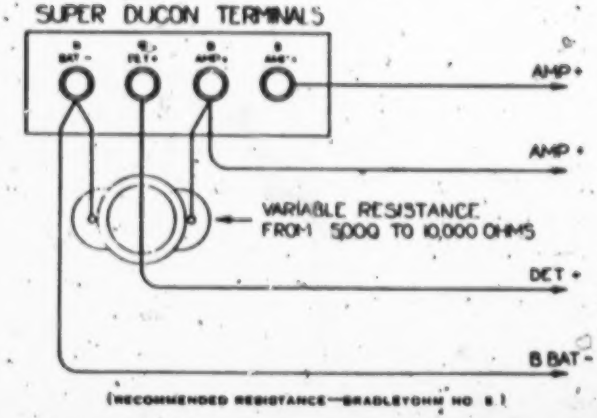


Diagram No. 4



PLAINTIFF'S EXHIBIT NO. 7, SERIES

196

General index of receivers

Name	Model	Use Diagram	Ground Note	Remarks
A-C Dayton	All models	2	See note	
Adams Morgan	Paragon Six	3		
Adler Royal	All models	2		Medium detector voltage
All Amax	Jr. and Sr.	3	See note	
Andrews	Deresnadyne	2		
Atwater Kent	9, 10, 19, 20 & Deluxe	2		
Blair	All models	2		
Bosch	Amborola	1		
Buckwalter	Supertone	2		
Chelsea	All models	2		
Colonial	All models	2		
Crosley	Trirdyn	2		Detector voltage critical
Crosley	Models 51 and 52	2		
David Grimes	Baby Grand	2	See note	Cable wires must be lengthened
David Grimes	4D	2	See note	
Day-Fan	All models	2	See note	Low detector voltage
De Forest	F-5	2		
De Forest	W-5	2	See note	
Eagle Radio	Eaglet	2		
Eagle Radio	Model D	2		
Eagle Radio-Electrola	Model F	1		
Fada		2		
Fada	195 A	2		
Federal	175A, 185A	2	See note	
Freed-Eisemann	141	1	See note	
Freed-Eisemann	FE-15, FE-18	2		
Freshman	NR-7, NR-45	1		
Garod	Masterpiece	2		
Garod	Model M	3		
Gilfillan	V and Georgian	1		
Gilfillan	GN-5, GN-6	2		Has conveniently long cable
Gilfillan	GN-1, GN-2	2		
	GN-4	2		Cable wires must be lengthened
Grebe	Syncrophase	2		
Henderson	Both types	2		
Henry Hyman		2	See note	
Jos. W. Jones	All models	2		
Kellogg	Wave Master	2		
Kennedy	15, 16, 20	2	See note	Low detector voltage
King Radio	All models	2		
Kolster Radio	Six	1		Very low detector voltage
Kolster Radio	Eight	1	See note	" " " "
Marlodyne		2		
Marvodyne		2	See note	
Melco Supreme		2		High voltage on detector
Music Master	50, 60, 100, 140, 175, 215, 300	2		
Music Master	250, 460	1	See note	
Newport Radio	V, V-200, V-100	2		
Operadio		2	See note	
Oriole	5, 6, 6-D and 7	2		Do not use the ground for antenna on this receiver
Pfanstiehl	All models	2		
Pinkatone		2	See note	
Plio-6		2		
Premier Radio	6-B	2		
Premier Radio	7-B	3		
Radiodyne	WC-10, 11, 14, 15	2		Low detector voltage
Sonora	Model C	2	See note	Note their instructions re detector
Splitdorf	All models	2		
Standardyne	B-5, BH	2		
Stromberg Carlson	No. 1-A	2		
Stromberg Carlson	New models	1		
Sypher Reflex		2	See note	
Thermiodyne	All models	2		
Thompson	V-50, Grandette S-60, Parlor Grand S-70	2		
Thompson	Minuet R-81, Duo-Tone C-61	1		
Thorola	Isiodyne	2		
Valley-Tone	All models	2		Low detector voltage
Ware	Type 250W	3		
Workrite	All models	2		

GROUND NOTE

Any receiver listed above that is referred to this note requires an extra ground wire which should be connected to the —B binding post of the Super-Ducon. Connect the ground post on the radio receiver and the —B post on the Super-Ducon together; and continue this wire to ground, preferably from the end attached to the Super Ducon.

DUBILIER CONDENSER & RADIO CORP., NEW YORK, U.S.A.

PLAINTIFFS' EXHIBIT NO. 7a.

(Blueprint of wiring diagram of Super-Ducon.)

CHANGES		
	A	Added 2340, 2347, 2331 to 2474, 2346 & 2340 to 2468, 2305 to 2470, 2301 to 2381
	B	Added Condenser in Schematic Diagram

JOJ 12-4-24

L.J.N. 12-4-24

Tech 12-4-24

SUPER DUCON WIRING DIAGRAM

SD800

5051

2474 INPUT FILTER CONDENSERS

2336

2337

2359

2405 OUTPUT FILTER CONDENSERS

2358

2405

2358

2337 Filament

Plate Trans. 2338

110 V. A.C. Plug 2311

.5 Mfd

.5 Mfd

2 Mfd.

2 Mfd.

Double Choke

Single Choke

Single Choke

SCHEMATIC DIAGRAM

ONDENSER & RADIO CORP., NEW YORK, U.S.A.

PLAINTIFFS' EXHIBIT NO. 7a.

(Blueprint of wiring diagram of Super-Ducon.)

CHANGES	
A	Added 2340, 2347, 2351 to 2414, 2346 to 2405, 2345 to 2401, 2335 to 2468, 2305 to 2470, 2301 to 2381 - 9 1/4, 25 [illegible]
B	Added Condenser in Schematic Diagram - Removed Switch [illegible]

2336 2337 2359 2405 OUTPUT FILTER CONDENSERS 2358 2405 2358 2405 2259 2460 GROUND TO CASE 2381 A

2337 Filament Trans. 2338 Plate Trans.

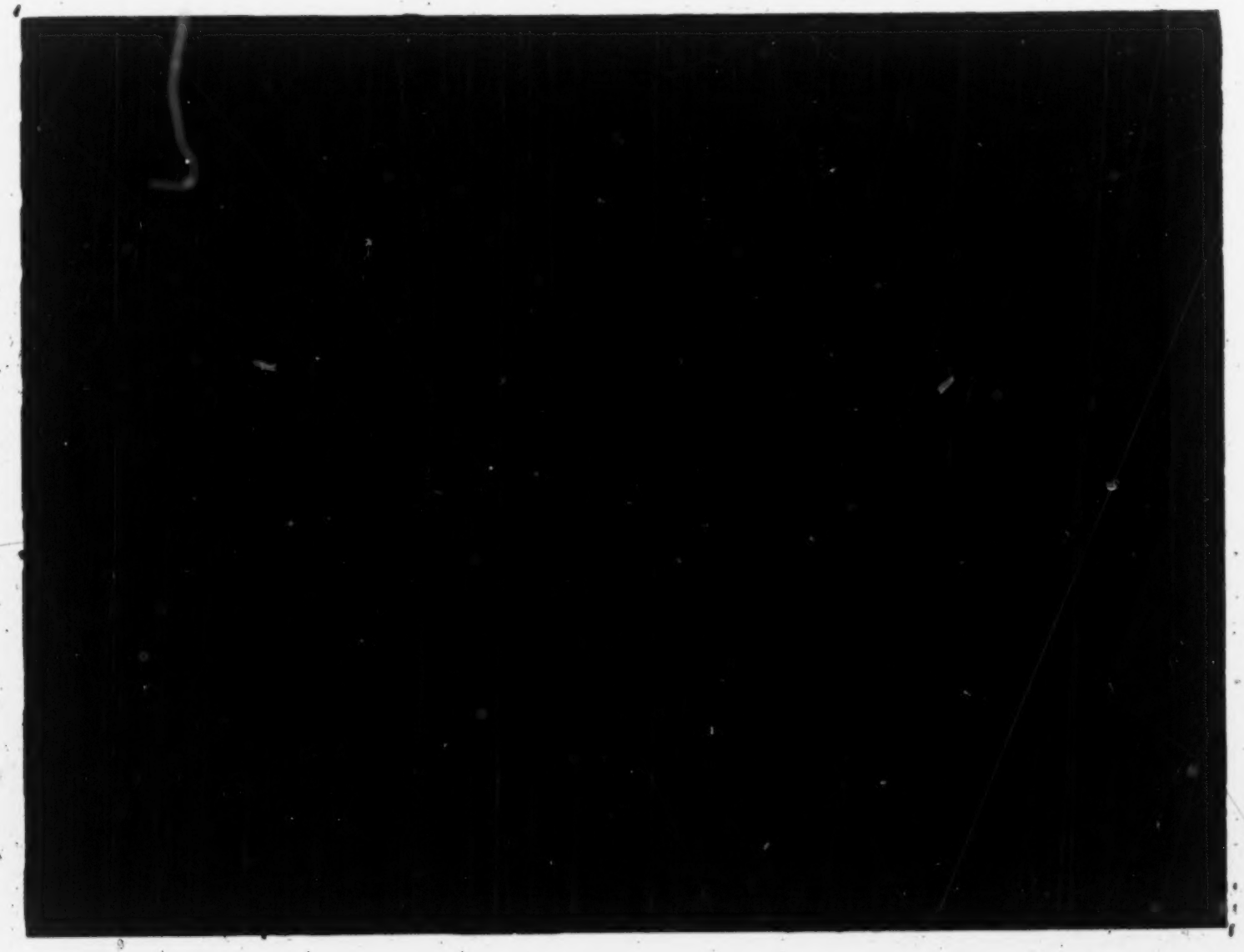
Double Choke 2 Mfd. Single Choke 2 Mfd. Single Choke 2 Mfd.

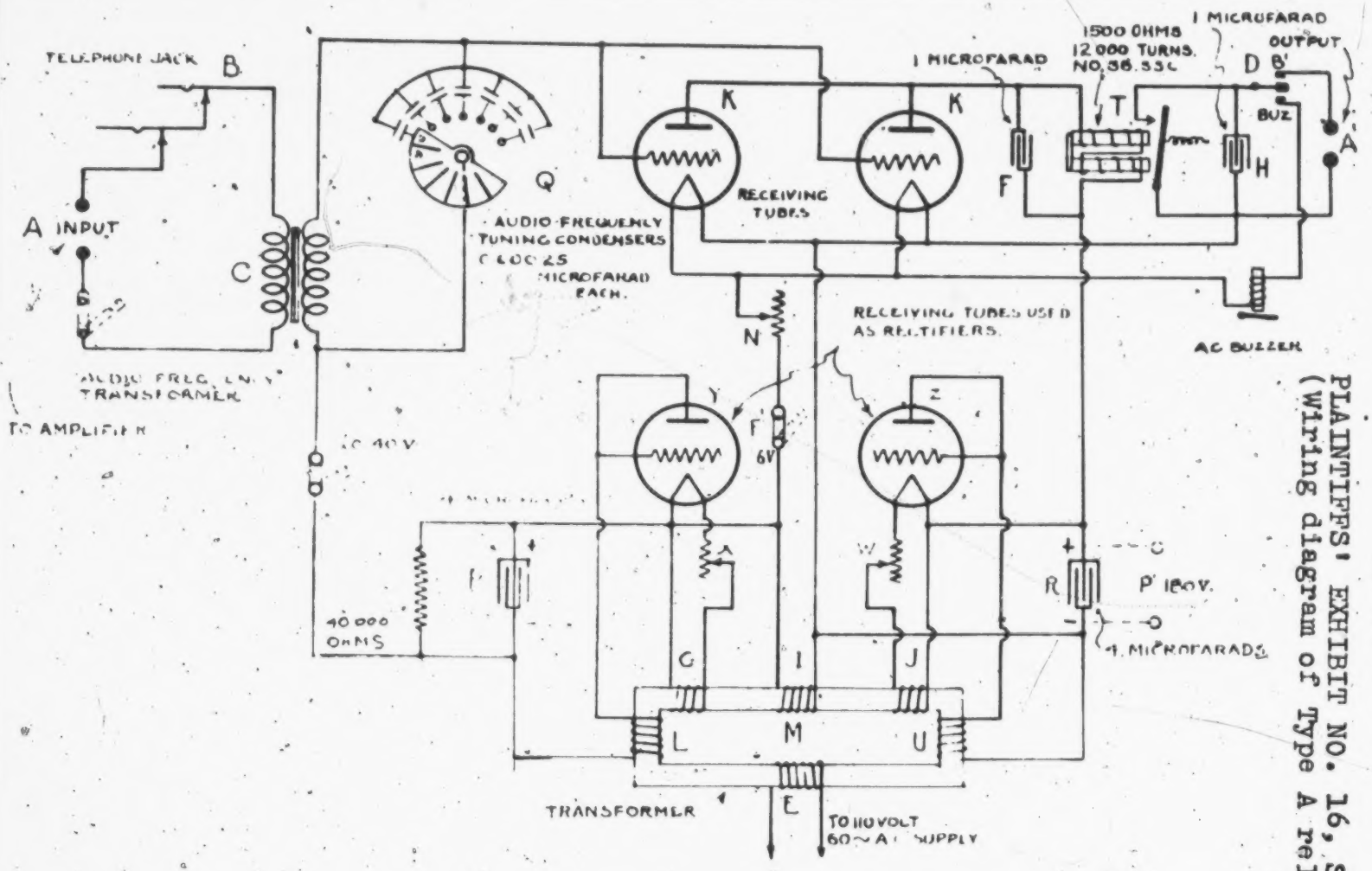
G P F- F+

GND -B BAT +DET. +AVC

SCHEMATIC DIAGRAM

PLAINTIFFS' EXHIBIT No. 15,
(Photograph of Type A relay).





A RELAY RECORDER FOR REMOTE CONTROL BY RADIO TYPE B

FOR USE ON 110 VOLTS 60~ CIRCUITS

FIG 4

PLAINTIFFS' EXHIBIT NO. 16, SHEET 1.
(Wiring diagram of Type A relay)

168

9

203-204

PLAINTIFFS' EXHIBIT NO. 16, SHEET 2.

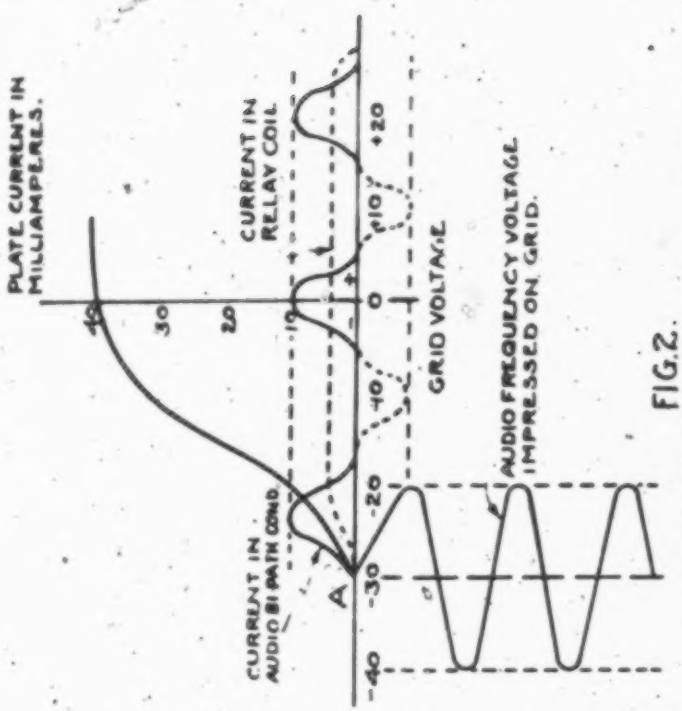


FIG.2.
TUBE CHARACTERISTIC FOR RELAY FOR REMOTE CONTROL BY RADIO.

Nov. 1. 21.

7848

B4

2

PLAINTIFFS' EXHIBIT NO. 16, SHEET 3.

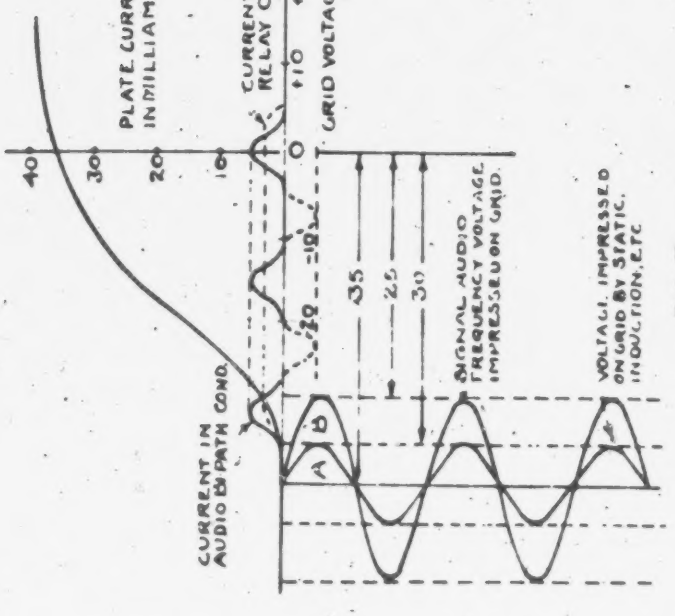


FIG. 3.

TUBE CHARACTERISTIC FOR RELAY FOR REMOTE CONTROL BY RADIO.

METHOD OF ELIMINATING STATIC, INDUCTION ETC. WHICH IS NOT STRONGER THAN THE SIGNAL, BY PROPER ADJUSTMENT OF GRID VOLTAGE.

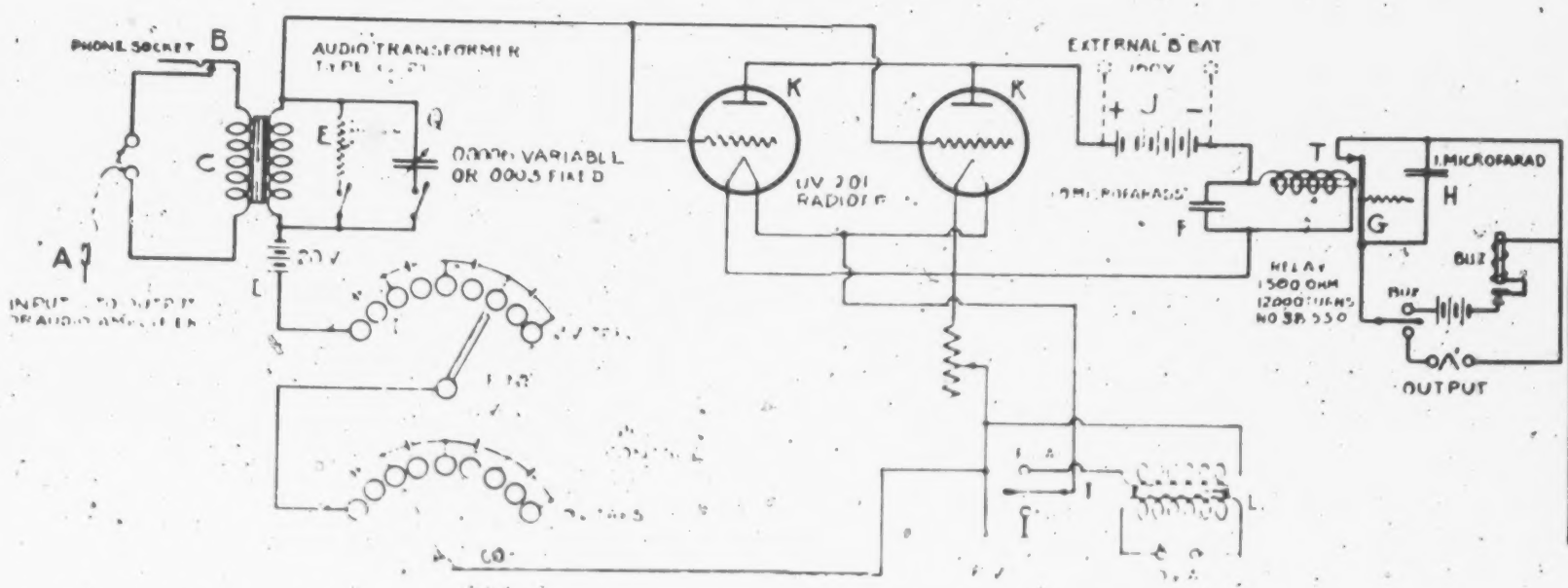


FIG.

RELAY RECORDER FOR REMOTE CONTROL BY RADIO

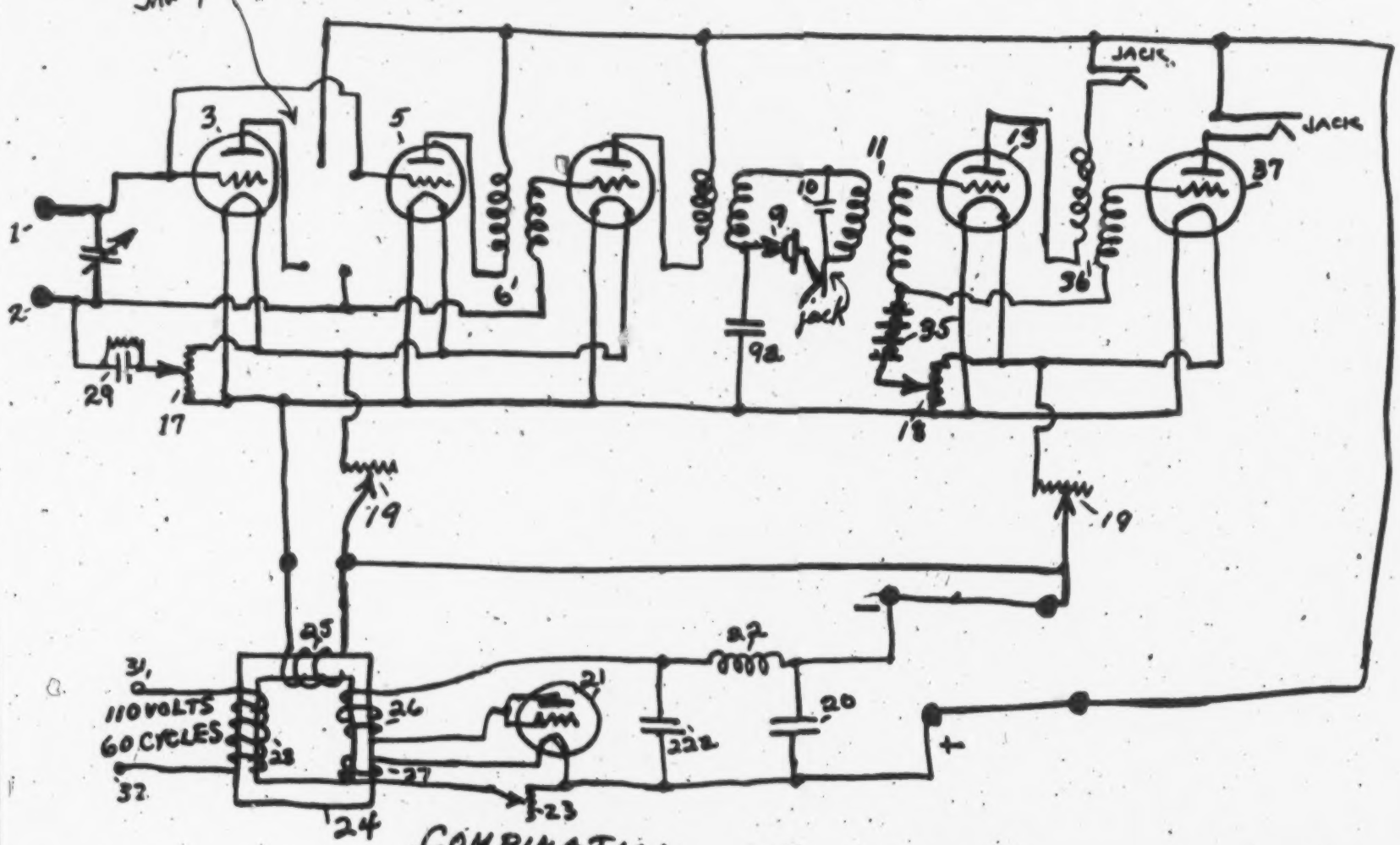
TYPE A

PLAINTIFFS' EXHIBIT NO. 17,
(Photograph of Bureau of Standards Set) 211— 21

Plaintiffs' Exhibit No. 68

H. C. Mashoff, Jr.

Clerk.



PLAINTIFFS' EXHIBIT NO. 18,
(Wiring diagram of Bureau of Standards Set.)

COMBINATION OF LOWELL AND DUNMORE EXHIBITS. NOS. 45 AND 46

213—
214

Radio Broadcast. Oct 1922

215—
216

PLAINTIFFS' EXHIBIT No. 21, Sheet 1,
(Newspaper and Periodical Articles.)
(Radio Broadcast, Oct. 1922)

Plaintiff Ex 21

Pltfs X 21

ELIMINATING "A" AND "B" BATTERIES BY GETTING POWER FROM THE LAMP SOCKET

SOME months ago there appeared a notice that the physicists of the Bureau of Standards were ready to hand over to the radio public a wonderful hoop in the shape of a triode amplifier which required no batteries of any kind for its operation. To many of us whose enjoyment of a concert has been spoiled by the sudden giving out of the filament storage battery, or who have been bothered by noisy, loose connections or bad cells in the plate battery, this announcement was indeed welcome. The interest of the public in the new device was so great that the Bureau had to get out a form reply to the numerous inquiries as to how soon the description of this battery-less amplifier would be ready.

In the July number of the Journal of the A.I.E.E. there is an interesting description of

REPLACING "A" AND "B" BATTERIES

This equipment, developed by the Bureau of Standards, does away with batteries for reception. Six tubes are employed in addition to a crystal detector. The Bureau is working on a device which will make use of a vacuum tube in place of the crystal

this amplifier by Physicist Lowell, of the Bureau, who has done the major part of the development work in the perfection of the new apparatus. The article shows the growth of the idea from a simple three-tube arrangement to the final product, which has the Bureau's seal of approval, an amplifier and rectifier outfit using altogether seven tubes and a crystal rectifier. Three tubes are used to make a radio-frequency amplifier feeding into a crystal detector circuit, which changes the modulated high-frequency current into an audio-frequency current; from this crystal circuit the current passes through two stages of low-frequency amplification into a loud speaker.

The filaments of all tubes are supplied with power from the secondary of a specially wound transformer, the primary of which draws its power from the ordinary sixty-cycle alternating current supply available in the average home. One rectifier tube, in combination with choke coils and condensers suitably connected supplies plate current for all the tubes and the other rectifier tube supplies the current used to excite the magnetic field of the loud speaker used. The latter tube is of the gas-filled variety, the Tungar tube used in small storage battery charging outfits. This type of tube, by the way, is a direct outgrowth of the Hewitt mercury arc rectifier, the source of electrons being a hot filament instead of the hot spot in the pool of mercury as used in Hewitt's rectifier.

The transformer and rectifier tubes are conveniently mounted in one box and the five-tube amplifier unit is compactly arranged in another; in order to make the amplifier operate it is necessary only to connect the flexible cord in the ordinary lamp socket. The amount of power drawn from the house circuit is about the same that is used by an ordinary fifty-watt lamp.

It seems incongruous to incorporate a crystal rectifier in a modern receiving set; we have thought that crystals were due to go into the discard, but this apparatus apparently gives them a new lease on life. Developments are being carried out in the tube laboratories, however, which will soon give us a tube of peculiar construction such that it may fill the place occupied by the crystal in this latest amplifier circuit.

With this new tube available, the bureau will undoubtedly substitute it for the crystal rectifier and this amplifier of Lowell's will then be the most convenient outfit we have seen. The dry cell and storage battery manufacturer will probably see their sales fall away to some extent, but the radio public at least that part of the public which can afford to maintain a seven-tube receiving set—will be greatly benefited by this new apparatus.

ARBITRATION SOCIETY OF AMERICA MAY END RADIO DISPUTES

ALTHOUGH the founding of this society has nothing directly to do with the present progress of radio, it is not at all impossible that some of the wrangles, necessarily occurring in an art going forward at such a rapid rate as is radio, may find their way into the court of the Arbitration Society and thus be settled much more expeditiously and fairly than is the

PLAINTIFFS' EXHIBIT NO. 21, Sheet 2 (Newspaper Article - New York Times, April 25, 1922, Page 9, "Eliminates Battery in New Radio Phone".

217-218

INCENDIARY STARTS 6 KIRBYVILLE FIRES

State Police Aid in Search for Maniac Who Uses Gasoline in Terrorizing Town.

$100,000 LUMBER BLAZE

Fire Is Followed by Fires at Hotel, Two Dwellings and Barn, the Last Being Consumed.

KIRBY, N. Y., April 24.—A fire-bug is being sought by the authorities here and the State Police. It is known that he started three fires today in Chappaqua, a mile away, on the Chappaqua road, and a fourth blaze at a point on the Armont and Mt. Misco road, this afternoon. It is believed he was responsible for a $100,000 lumber fire last night in the yards of Young, Halsey & Co., in this town.

It was necessary to get help from the fire departments of White Plains, Mount Kisco, Chappaqua, Briarcliff and Pleasantville to fight the lumber fire. About 10 o'clock this morning three calls for fire apparatus were received from Kirbyville.

The fires occurred at the same time, and the police say, all were set by an incendiary. The first was at the Lexington Hotel, a small house, occupied only by Cornelius Link and his son and daughter. Flames were seen in three rooms in the building by a taxicab driver, who awakened the occupants. A gasoline can was found near by and it was evident that gasoline had been used by the firebug. The damage was about $1,500.

Three persons were asleep in the home of Henry Hoffman when fire was discovered there. All got out safely. A gasoline can was found near this house and a short one hundred feet from the Lexington Hotel. The flames were put out before much damage was done.

At the home of M. F. Daley, 1,000 feet from the hotel, a bale of hay, soaked with gasoline, was found burning. It was taken away before the building caught fire.

The afternoon fire consumed the barn owned by Frank McMahon. The structure was burned to the ground, no water being available. The loss was estimated at $5,000.

No one had been in the barn for several hours. When the blaze was discovered the interior was a mass of flames. McMahon and his men barely had time to save an automobile. The firebug defeated their efforts to prevent the flames from reaching the dwelling.

Members of the State constabulary and deputies searched the woods for several miles without avail. The barn was about a mile from the houses set afire in the morning.

Residents for miles around tonight kept watch on their property. Guards also were on the lookout for the firebug.

WOMEN GUILTY OF ANARCHY.

Bronx Jury Convicts Two Distributors of Radical Literature

ELIMINATES BATTERY IN NEW RADIOPHONE

Government Invention Replaces Undesirable Storage Unit With Electric Power.

WASHINGTON, April 24.—Elimination of the storage battery, the most expensive part of the home made radio receiving set, is now possible according to the Bureau of Standards of the Department of Commerce.

The receiving sets which are now used in receiving radio signals, music and the like over distances of perhaps hundreds of miles require a storage battery to light the filaments of the electron tubes. The battery must be charged from time to time, it is bulky and heavy, the acid in it is a source of danger and damage to the household and altogether it constitutes a drawback to the general use of radio sets.

The receiving set developed by the bureau connects with the ordinary electric lamp socket. The set may be used with any type of antennae, and by special means of connection it is even possible to use the electric light wires themselves as the antennae. The set consists essentially of an amplifier with minor auxiliary parts. It is described in a paper which will be published by the Bureau of Standards about May 1.

The amplifier will utilize a sixty cycle current supply for both filaments and plates of the electron tube, thus eliminating much of the interference met in an ordinary amplifier circuit.

"This interference," an announcement says, "has been practically eliminated by balancing resistances, grid condensers and special grid leaks of comparatively low resistance, telephone transformer in the output circuit, and crystal detector, instead of electron tube detector."

In the final form of the amplifier there is only a slight residual hum, which is not objectionable. The amplifications obtained with alternating current supply was as good as that obtained with the same amplifier used with the direct current supply. The complete unit is light, compact and portable. For the reception of damped waves, the amplifier as constructed worked most satisfactorily for wave lengths from 200 to 700 metres. This range was determined by the working range of the radio-frequency transformers used.

"By using suitable radio-frequency transformers it is expected that the amplifier will be effective for the reception of damped waves and undamped waves as long as 10,000 metres.

PEORIA, Ill., April 24.—If science can discover how the lightning bug's vending apparatus flashes light waves, present day radio science may be superseded, E. U. Shalkhauser, professor of physics and radio science at Bradley Polytechnical Institute here, said today. He believes that the firefly can send out an electric magnetic wave, but its source is still a mystery and this he is investigating.

"If we could find this source, I think we could throw away all our antennae, aerial bulbs and other apparatus, because in my belief the lightning bug may have a little power plant of his own more highly perfected than any of radio science," said Professor Shalkhauser.

"It has been proved repeatedly that the wave transmitted by the bug is a cold light wave. The light wave, heat wave and radio wave are the same in a sense, because they have the same frequency. It may be possible to tune down to a sufficiently low wave length to discern the bug."

CAUGHT SMUGGLING CHINESE

Captain and Crew Seized After 29

You in Bi
Price impr with torie Safe Com you learn Alwa than est qu
GF Of
The Ger
New York
138 Br
Phone
NEW Y

PLAINTIFFS' EXHIBIT NO. 21, SHEET 3,
(Washington Herald, April 14, 1922,
Page 9, "Electron Tubes Replace
Battery")

219 — 220

[redacted]

George F. Warfield, organist.

William W. Welker aged 46, a former resident of this city, died this morning in a Washington hospital after a long illness. He is survived by his widow, his parents, Mr and Mrs George W. Welker, 111 North Royal street, a brother and sister. Mr. Welker was a veteran of the Spanish-American War. He was a member of Alexandria Lodge No. 758, Benevolent and Protective Order of Elks, and Osceola Tribe of Red Men. The funeral will be held at 1:30 o'clock Monday afternoon at 227 Thirteenth street southwest, Washington, and burial will be in Arlington National Cemetery.

The annual Holy Thursday procession held in St. Mary's Catholic Church today will be repeated at the Good Friday services tomorrow morning.

RADIO MEASURE TO BE RI[redacted]SHED

Secretary Hoover [redacted] interest has been re[redacted] o the The bill which [redacted] traffic rules of [redacted] generally regarded as [redacted] still needs "polishing." [redacted] story Hoover expects his [redacted] necessary action Monday, on [redacted] transmittage on M[redacted]

Representative [redacted] fairs will introduce the [redacted] House, while Hoover said, at the [redacted]

EZ
TABLETS RELIEVE CONSTIPATION
At Hooton and Other Good Drug Stores

How to Banish Piles

[redacted] Dr. Leonhardt's HEM-ROID.

[redacted] Dr. Leonhardt's HEM-ROID.

[redacted] Dr. Leonhardt's HEM-ROID.

PLAINTIFFS' EXHIBIT NO. 21, SHEET 4, (New York Globe, April 25, 1922, page 13, Article on "Elimination of Battery")

221— 222

E GLOBE AND COMMERCIAL ADVERTISER, NEW YORK, TUESDAY, APRIL 25, 1922.

MENT

Government to Describe Set Minus Battery

Elimination of the storage battery, the most expensive part of the home-made radio receiving set, is now possible according to the Bureau of Standards of the Department of Commerce in a statement issued yesterday.

The receiving sets which are now used in receiving radio signals, music, etc., over distances of perhaps hundreds of miles require a storage battery to light the filaments of the electron tubes. The battery must be charged from time to time, it is bulky and heavy, the acid in it is a source of danger and damage to the household and altogether it constitutes a drawback to the general use of radio sets.

The receiving set developed by the Bureau of Standards makes connection with the ordinary electric lamp socket. The set may be used with any type of antenna, i. e., with the ordinary elevated wire antenna, a coil antenna, or special forms of antenna. By special modes of connection, it is even possible to use the electric light wires themselves as the antenna, but the signals are likely to come in with less strength when this is done.

The receiving set consists essentially of an amplifier with minor auxiliary parts. This is described in a paper which has been prepared and will be published by the Bureau of Standards about the first of May, and sold at 5 cents a copy. A few details of the amplifier, which utilizes 60-cycle current supply for both filaments and plates of the electron tubes, are as follows: This amplifier has three radio-frequency stages and two audio-frequency stages, and uses a crystal detector. The 60-cycle current when used in an ordinary amplifier circuit introduces a strong 60-cycle note which offers serious interference. This note has been practically eliminated by balancing resistances, grid condensers and special grid leaks of comparatively low resistance, telephone transformers in the output circuit, and crystal detector, instead of electron tube detector. In the final form of the amplifier, there is only a slight residual hum which is not objectionable. The amplification obtained with a. c. supply was as good as that obtained with d. c. supply. The complete unit is light, compact and portable. For the reception of damped waves, the amplifier as constructed operated most satisfactorily for wave lengths from 300 to 750 meters.

DEMAND

LISTENING IN

Steamers of the Admiral Line on the Pacific Coast have installed high power receiving equipment for the use of passengers, according to reports. The purser of the S. S. Yale is said to have reported to the Atlantic-Pacific Radio Supply Company of the Rockridge Station at Oak Island that broadcasted concerts had been received on his steamer. Several steamers of the line in question have dances by radio music as a regular part of the life on board. On one of the ships, the Ruth Alexander by name, a magnavox has been placed in the main salon and a connection in each cabin.

The wireless operator of the S. S. Luckenbach has just sent word to the General Electric Company that on March 30, between the hours of 3.50 and 4.35 in the morning, while the ship was south of Panama in the Pacific at seven degrees north of the equator, he had been able to pick up a musical concert sent out from Station W G Y in Schenectady. This is by airline a distance of more than 2,000 miles and establishes a new record for the General Electric station.

The ship operator, W. W. Brairs, reports the time he heard each selection, named each selection and his letter bears a confirmation of the ship's log signed by the master of the vessel. His report checks up exactly with the log of the concert broadcasted that night by the General Electric Company.

Prior to the letter from the S. S. Luckenbach, the southernmost point reached by the Schenectady station was Tela, Honduras. Richard H. Dudgeon, chief operator on the S. S. Copenane, United Fruit liner, tied up in the port of Tela, reported that he had distinctly heard the programme sent out from W G Y on March 14. Other reported hearing W. G. Y. are Santa Clara, Cuba, and Mexico City.

What is believed to have been one of the earliest feats of amateur radio telephony has just b light in the finding of the Minneapolis Tim 1902. The clipping o a the effects of D. McN to the president of the ation of America. Thu picture of the status raphy at that time, theories held by popu cerning it. The clip part:

"While experimentin telegraphy Friday ev Nichol, general telegra fice road, was startle message from some on experimenting with th

"The message was out letters and word through so distinctly as McNichol that he was a very satisfactory tes

"There was nothing d and Mr. McNichol c some ordinary electrica caused it. But a few the instrument clicked letters were plain. La more connection to the words could be spelle 'other' was the first o conditions.

"Mr. McNichol now ously operated, and h

Sandman Stories For the Kiddies

Bugs Wiggly Man-In-the-Moon and many other delightful juvenile characters will delight the youngsters at bedtime—and the grown-ups too.

Let us install a

Westinghouse

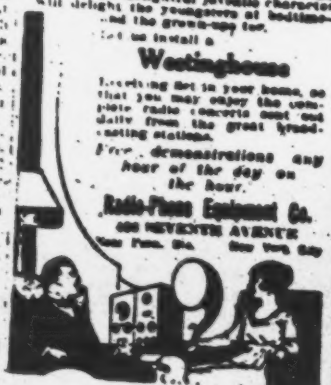
Receiving Set in your home, so that you may enjoy the complete radio concerts sent out daily from the great broadcasting stations.

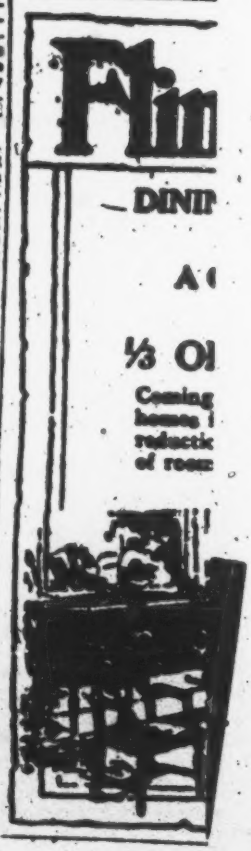
Free demonstrations any hour of the day or the hour.

Radio-Phone Equipment Co.

695 SEVENTH AVENUE

New York City





PLAINTIFFS' EXHIBIT NO. 21, SHEET 5,
(Washington Star, April 24, 1922,
Page 10, "Storage Batteries for
Radio Passe")

223 – 224

THE WASHINGTON POST: TUES

RADIO DEPARTMENT

der Web il Efficient, Yet Simpl

[redacted] 8, "How [redacted] Batteries"

of the mos[redacted] uning indu[redacted] s the spid[redacted] coil. They [redacted] and it is quite possible to make [redacted] erent sizes in their [redacted]s and [redacted]m the same way that honeycomb coils are used. The means that [redacted] may be arranged to plug in in [redacted] me manner and by making [redacted] larger it is possible to get on [redacted] her wave lengths.

[redacted] coils may be used: One as [redacted] secondary and tickler for a [redacted] tive set with a vacuum tube [redacted] coils as a primary and sec- [redacted] with a crystal set. The hook [redacted] he former case is the same as [redacted] eycomb coils and in the latter [redacted] will be the same as for a loose

[redacted] coupler. In regard to the [redacted] the coils and how many turns [redacted] to put on them the best thing [redacted] to actually make them up [redacted] periment around with them. It [redacted] t impossible to actually give [redacted] ber of turns of wire to put [redacted] coils and the way to do is to [redacted] e core or frame a good size [redacted] wind it full of wire. About [redacted] five inches in diameter should [redacted] right for a start. After the [redacted] all wound on connect the set [redacted] securely and try it out. If [redacted] too much wire on, the slider [redacted] y yard will come in. If this [redacted] ase remove some of the wire [redacted] again. Keep this up until [redacted] le is heard and then try tak- [redacted] one turn at a time until the [redacted] sults are obtained. Be sure [redacted] his test while you know that [redacted] it is in progress as otherwise [redacted] ht take all of the wire off [redacted] and still not hear any music.

The Winding Form.

[redacted] be seen in the drawing, the [redacted] very simple to make and it [redacted] primarily of a piece of card- [redacted] ich as a heavy pad back. [redacted]

RADIO PROGRAM

TUESDAY, APRIL 25, 1922.

WWZ—Postoffice Department.
10 a. m.—Weather report for District of Columbia, Pennsylvania, Ohio, Maryland, Virginia and West Virginia.
10:30 a. m.—Marketgram (fruit and vegetable) on 1,160 meters.
12:30, 2:15 and 3:30 p. m.—W. marketgram telegrams on 1,950 meters.
5 p. m.—Wholesale dairy report on 1,160 meters, by radiophone.
7:30 and 8 p. m.—Market report on 1,160 meters, by radiophone.
9:30 p. m.—Weather report.

WPM—Thomas J. Williams Company.
12:30 p. m.—News items and report on stolen automobiles.

WJH—White & Boyer Co.—7:00 p. m. (Direction of Theodore Hoffman—H. K. L.)on, operator.)
"Address, "Business Ethics," by Mr. Isaac Gans, vice president Washington Chamber of Commerce; orchestra selections, by the Variety Club orchestra of Washington; fox trot, "Everybody Step" (Berlin); waltz, "April Showers (B[redacted]); fox trot, "Leave Me With a [redacted]cohler); soprano solos, Miss [redacted]ngwell-Smith, "Rose in My [redacted](Courtney); "Ring Me to [redacted]reams) Miss Roberta Gerou, piano; piano solos, Mrs. H. [redacted] Rustle of Spring" (Sinding) [redacted] India" (Rimsky-Korsakoff), [redacted] solos, Mr. Fred Komle, "[redacted]Stealing," Mr. Byron Bled[redacted] piano; orchestra selections, [redacted] variety Club orchestra of [redacted], fox trot, "[redacted]n't Leave [redacted]my;" waltz, "Three o'Clock" (Bohm); [redacted] Merriage" (Gabriel); "[redacted] Baby Fingers" [redacted] solos, Mr. James Lambert [redacted] (McGill); "I [redacted] You, Dear [redacted]), Mr. Theodore Hoffman [redacted] piano; piano solos, "Love's [redacted]" (Nevin); regular medley, Mrs. H. J. Reed; orchestra selections, by the Variety Club orchestra of Washington, fox trot, "Wabash Blues" (Meinken); waltz, "Ohio Shore" (Akst); fox trot, "Grapey;" harpland solos, Ms. Fred Komle; selection, "Swanee River Moon," Mr. Byron Blodgett at the piano; soprano solo, Miss Mildred Maxwell-Smith, "My Garden" (D'Hardelot); "A Dream" (Bartlett), Miss Roberta Gerou, at piano; orchestra selection, "The Bells of Araby."
The Variety Club orchestra of Washington, Mr. Justin McCarthy, violin, director; Mr. Isadore Rosenberg, pianist; Mr. James Briscoe, banjo; Mr. Homer Bland, drums; Mr. Benjamin Grotman, saxophone; Mr. J. H. Whiting, cornet.

WWZ—Doubleday-Hill Electric Company.
4:30 to 5:30 p. m.—"Tony and Pennant," Part I (von Suppe); Viennese Waltz, piano (Gaertner); "The Bird and the Saxophone" (Hager-Ring); "Narbstuck," piano (Schuman); "Faust," soprano (Gounod); "Valse," piano (Chopin); "Rigoletto," soprano and baritone (Verdi); "Caprice Viennois," violin (Kreisler); "Fantaisie," piano (Chopin); "Lohengrin," soprano (Wagner); "Don Juan Fantaisie," piano (Liszt); "Tony and Pennant," Part II (von Suppe); "The Woodland Flirt" (Hager-Ring); "On Wings of Song," piano (Mendelssohn).

WJH—Newark.
11 a. m.—Music, government weather forecast.
12 m.—Music, government weather forecast, agricultural report.
1 p. m.—Music.
2 p. m.—Music.
5:05 p. m.—Shipping news.
7 p. m.—Music.

NEW HOME-MADE SET ELIMINATES BATTERY

Bureau of Standards Perfects Apparatus Which Runs With Lamp Socket.

Elimination of the storage battery, the most expensive part of the home-made radio receiving set, is now possible according to the bureau of standards of the Department of Commerce.

The receiving sets which are now used in receiving radio signals, music, &c., over distances of perhaps hundreds of miles require a storage battery to light the filaments of the electron tubes. The battery must be charged from time to time, it is bulky and heavy, the acid in it is a source of danger and damage to the household and altogether it constitutes a drawback to the general use of radio sets.

The receiving set developed by the bureau of standards makes connection with the ordinary electric lamp socket. The set may be used with any type of antenna, i. e., with the ordinary elevated wire antenna, a coil antenna, or special forms of antenna. By special modes of connection, it is even possible to use the electric light wires themselves as the antenna, but the signals are likely to come in with less strength when this is done.

The receiving set consists essentially of an amplifier with minor auxiliary parts. This is described in a paper which has been prepared and will be published by the bureau of standards about May 1, and sold at 5 cents a copy. A few details of the amplifier, which utilizes 60-cycle current supply for both filaments and plates of the electron tubes, are as follows: This amplifier has three radio-frequency stages and two audio-frequency stages, and uses a crystal detector. The 60-cycle current when used in an ordinary amplifier circuit introduces a strong 60-cycle note which offers serious interference. This has been practically eliminated by balancing resistances, grid condensers and special grid leaks of comparatively low resistance, telephone transformer in the output circuit, and crystal detector, instead of electron tube detector. In the final form of the amplifier, there is only a slight residual hum which is not objectionable. The amplification obtained with a. c. supply was as good as that obtained with the same amplifier used with d. c. supply. The complete unit is light, compact and portable. For the reception of damped waves, the amplifier as constructed operated most satisfactorily for wave lengths from 200 to 750 meters. This range was determined by the working range of the radio-frequency transformers used. By using suitable radio-frequency transformers, it is expected that the amplifier will be effective for the reception of damped waves and undamped waves as long as 10,000 meters. For the reception of undamped waves, a separate heterodyne should be employed. The paper gives circuit diagrams and states the values of the condensers, resistors and inductors used.

BUG CODE MAY UPSET RADIO.

PLAINTIFFS' EXHIBIT NO. 21, SHEET 6,
(Washington Star, April 24, 1922,
Page 10, "Storage Batteries for
Radio Passe")

Fame
Brand

REGULAR PRICES

Olive Oil, ½-pt. can 29c
a, bottle (double strength) . . 12c
lad Dressing; bottle 27c
No. 1 can 13c
ured Bacon (in strips), lb . . 24c
ance, large can 17c
, evaporated, lb 38c
. doz 28c
ch Rolls, Size 12x18 inches 50 sheets, 7c
sh Cleanser, can 8c
tions, lb 12c
ottles 96

our—24 Lb Bag 15

LOW PRICE
Tea, lb 15c
rder Tea, lb . . . 15c
Breakfast Tea, L 35c
a, 46c

-Oz. Jar, 11c
-Oz. Jar, 23c

PASTEURIZED
ILK
QUARTS, 11c

TATO CHIPS
At All Times Crisp,
c and 9c; Bulk, 1 lb., 39c

RY best? Order
R'SBREAD

STORAGE BATTERY FOR RADIO PASSE

BY RAI

Bureau of Standards Finds Way to Eliminate Danger and Expense.

Elimination of the storage battery, the most expensive part of the home-made radio receiving set, is now possible, according to the bureau of standards of the Department of Commerce in a statement released today.

The receiving sets which are now used in receiving radio signals, music, etc., over distances of perhaps hundreds of miles require a storage battery to light the filaments of the electron tubes. The battery must be charged from time to time, it is bulky and heavy, the acid in it is a source of danger and damage to the household, and altogether it constitutes a drawback to the general use of radio sets.

Connected at Lamp Socket.

The receiving set developed by the bureau of standards makes connection with the ordinary electric lamp socket. The set may be used with any type of antenna, i.e., with the ordinary elevated wire antenna, a coil antenna, or special forms of antenna. By special modes of connection, it is even possible to use the electric light wires themselves as the antenna, but the signals are likely to come in with less strength when this is done.

The receiving set consists essentially of an amplifier with minor auxiliary parts. This is described in a paper which has been prepared and will be published by the bureau of standards about May 1, and sold at 5 cents a copy. A few details of the amplifier, which utilizes 60-cycle current supply for both filaments and plates of the electron tubes, are as follows: This amplifier has three radio-frequency stages and two audio-frequency stages, and uses a crystal detector. The 60-cycle current, when used in an ordinary amplifier circuit, introduces a strong 60-cycle note which offers serious interference.

Practically Eliminated.

This has been practically eliminated by balancing resistances, grid condensers and special grid leaks of comparatively low resistance, telephone transformer in the output circuit, and crystal detector, instead of electron tube detector. In the final form of the amplifier there is only a slight residual hum which is not objectionable. The amplification obtained with alternating current supply was as good as that obtained with the same amplifier used with the direct current supply. The complete unit is light, compact and portable. For the reception of damped waves the amplifier as constructed worked most satisfactorily for wave lengths from 300 to 750 meters. This range was determined by the working range of the radio-frequency transformers used. By using suitable radio-frequency transformers, it is expected that the amplifier will be effective for the reception of damped waves and undamped waves as long as 10,000 meters. For the reception of undamped waves, a separate het-rodyne should be employed. The paper gives circuit diagrams, and states the values of the condensers, resistors and inductors used.

TRACE "FRYING NOISES".

NAA—Naval R
2:30 p.m.—Al
[illegible] meters o
12 noon—and
followed by w
ceipts.
2 p.m.—Arbo
livered by Sec
Department of
10:30 p.m.—N
length 2,650 m
NOF—Naval
lb. C.
6:30 to 9:15
Fridays: Mus
WWL—Post O
10 a.m.—W
10:30 a.m.—S
phone
12:30 p.
p.m.—Telegram
meters
WWL—Doubled
pers)
1:30 to 2:30
Base ball s
WJZ—Newar
Every hour
eral program
11 a.m., 12
p.m.—Weather
2:05 p.m.—Sh
9:25 p.m.—Fi
7:40 p.m.—Ste
Magazine
7:30 to 9:40 p.m
Yelling, harpist
Fred McPherso
Koenig, violini
will be announc
9:20 to 10:15 p
Recital by Ma
soprano: Herse
accompanist. I
(Coombs), "Ho
"Thank God
Riegel), "Oh! D
Riegel), "Just a
J. Wood), "Irish
"Here Are F
(Buhuque), "M
cott), "Un Bel
"Madame Butter
song" (Napra
Land" (Oriental
Russian Folk So
van Has Rested
(Phillips), "Th
Piano Solo—
(Beethoven).
"The Nightingal
"Pastoral et Va
Hungarian Rha
KYW—Weste
(1020 meters)
9:35 a.m.—Ope
Chicago Board o
until 1 p.m.
1:20 p.m.—Cl
tions.
2:15 p.m.—Ne
ports.
4:15 p.m.—New
reports.
6:20 p.m.—New
stock reports.
7:30 p.m.—Chil
9:9 p.m.—Con
en, soprano; Flo
to; Frank J. Ph
mental concert i
limit. Clem
Grace McKeen,
Landis, dramati
Sidney Spiegal,
dan).
9 p.m.—News a
WBBM—Wes
(1020 meters)
10 to 12:30 a.m.
12:30 to 1 p.m.
2 to 3:30 p.m.—
4 to 6:30 p.m.—
7:30 p.m.—Boot
7:45 p.m.—Spor
market reports.
York Stock Exc
port
8 p.m.—Piano

CONCLUSIONS

Transmission at 220 kv. has been invested with a certain glamour, and the further investigation has been carried the more certain it appears that transmission at this voltage will only differ in degree from transmission at lower voltages, with which we are familiar. No new or startling effects are expected or appear probable.

The unequal voltage distribution over long insulator strings can be eliminated to the degree where individual units will be stressed less than they now are on lines in commercial operation. This is effected by shield rings which at the same time can be so designed as to keep any accidental arc well away from the insulators. Corona upon insulators and hardware is also prevented.

Standard suspension insulators can be used, so that 220-kv. transmission need not wait upon the design and trial of new types of insulator.

Transformers and switches are already developed, and have been built by more than one manufacturer.

The corona constants of large cables are known within rather narrow limits so that lines can be confidently designed to have definite known losses.

The charging current of commercial lines is also sufficiently well determined so that calculations of voltage regulation will be accurate.

There are therefore no apparent obstacles in the way of 220-kv. transmission, the only requirement being that the amount of power to be transmitted shall be sufficiently large, and the distance great enough to warrant the cost of 220-kv. equipment. The increased carrying capacity of the transmission lines then more than offsets the equipment cost and 220-kv. transmission becomes more economical than at any lower voltage.

Note on the Development of an Electron Tube Amplifier

Which Uses 60-Cycle Alternating Current to Supply Power for the Filaments and Plates

BY P. D. LOWELL

Associate Physicist, Bureau of Standards

Electron tube amplifiers now form an important part of practically all radio receiving sets except the most simple types. Storage cells, which have heretofore usually been required for operating amplifiers, require constant attention, are bulky and heavy, and have other serious disadvantages. The dry cells, which are often used as a source of plate voltage, have a comparatively short life and are expensive and inconvenient. It would be much more convenient to use an amplifier which could be supplied with power from 110-volt, 60-cycle mains.

This paper describes a five-stage amplifier which operates satisfactorily on 60-cycle supply for both filaments and plates. This amplifier has three radio-frequency stages and two audio-frequency stages, and uses a crystal detector. A special transformer with five windings is used, the primary being supplied with 110-volt a-c. The 60-cycle current which is used in the amplifier is not rectified [illegible] of comparatively low resistance, [illegible] tube detector. In the final form of the amplifier, there is only a slight residual hum which is not objectionable. The amplification obtained with a-c. supply was as good as that obtained with the same amplifier used with d-c. supply. The complete unit is light, compact, and portable. For the reception of damped waves, the amplifier as constructed operated most satisfactorily for wave lengths from 300 to 750 meters. This range was determined by the working range of the radio-frequency transformers used. By using suitable radio-frequency transformers, it is expected that the amplifier will be effective for the reception of damped waves and undamped waves as long as 10,000 meters. For the reception of undamped waves, a separate heterodyne should be employed. The paper gives circuit diagrams, and states the values of the condensers, resistors and inductors used.

ELECTRON tube amplifiers now form an important part of practically all radio receiving sets, except the most simple types. Such amplifiers are in fact necessary to receive distant stations, or when using coil antennas. For good operation, amplifier tubes require for the filament a source of voltage of very constant value (usually about 6 volts) and for the plate a source of voltage of from 40 to perhaps 200 volts. The filament voltage is usually supplied by storage cells, and the plate voltage by dry cells. The maintenance of these cells in operating condition, especially the storage cells, is often a source of much difficulty and annoyance. The storage cells are necessarily bulky and heavy, require constant attention to maintain proper charge and density of electrolyte, give off injurious acid or other fumes, and are subject to considerable variations of voltage during the period of discharge. The development of an amplifier which can be supplied from the ordinary 110-volt a-c. lighting mains is of considerable practical importance, since it would eliminate the practical difficulties of maintaining storage cells. The amplifier using such a-c.

supply has the important advantages of reliability, convenience, and cheapness both in first cost and operating cost.

Such an amplifier using five stages of amplification has been developed at the Bureau of Standards. There are three stages of radio-frequency amplification and two stages of audio-frequency amplification. It is the purpose of this note to describe briefly this amplifier.

The first arrangement, tried consisted of one radio-frequency stage of amplification, detector and one audio-frequency stage. The filaments of the three tubes were lighted by 6 volts supplied by a step-down transformer, the primary of which was connected to the 110-volt, 60-cycle power mains. The circuit is shown in Fig. 1.

In Fig. 1, the filament lighting transformer is shown at *A*, supplying voltage for the filaments of electron tubes *B*, *C* and *D*. The amplifier input circuit is connected to the grid of tube *B* and to the slider of the balancing resistance *E*, the latter having a resistance of 200 ohms and being connected across the filament line. A radio-frequency transformer is shown at *H*,

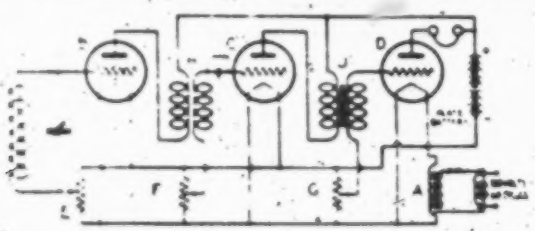


Fig. 1 Two-Stage Amplifier Circuit Using Two Detectors

a balancing resistance at *F*, an audio-frequency transformer, at *J*, and another balancing resistance at *G*. The purpose of the balancing resistances *E*, *F*, *G*, is to keep the normal voltage of the grids at a steady value with respect to the average voltage of the electrical midpoint of the filament and thus to eliminate the hum which variations of the grid voltage would cause. These balancing resistances are adjusted until the hum is eliminated. Reception was accomplished with this circuit but there was considerable 60-cycle hum present in spite of the beneficial effect of the balancing resistances.

The employment of a crystal detector in place of the electron tube detector reduced the 60-cycle hum very considerably. This circuit is shown in Fig. 2.

When an electron tube is used as the detector, there is impressed on both the plate and the filament a 60-cycle a.c. voltage which, although small, becomes very objectionable when amplified by one or two stages of audio-frequency amplification. When the crystal detector is used, no 60-cycle voltage is supplied to the detector circuit. The radio-frequency transformer whose output is delivered to the detector circuit prevents the passage in any appreciable amount of 60-cycle current supplied to the radio-frequency stage, and such voltages are not present in the crystal detector circuit and do not reach the input of the audio-frequency stage.

The employment of a crystal detector may at first seem objectionable, since with the crystal as ordinarily used it is rather difficult to find a point of good sensitivity. But tests on this amplifier showed that careful adjustment of the crystal detector was not necessary because the radio-frequency amplification preceding

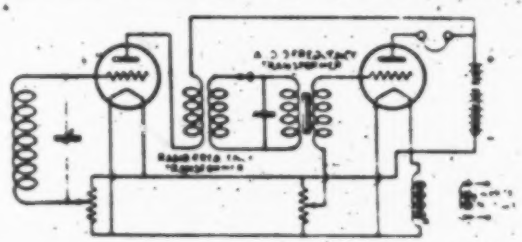


Fig. 2 Two-Stage Amplifier Using Crystal Detector

the detector usually gave sufficient signal strength so that a point of sufficient sensitivity could be easily found.

This circuit gave quite good results. The 60-cycle hum was practically eliminated and the crystal detector gave almost as good rectification as the tube detector.

It was found that better amplifying action could be obtained by inserting condensers of about 0.02 microfarad capacity, shunted by 2-megohm grid leak resistances, in the grid circuits, in series with the sliders of the balancing resistances. The grid condensers and grid leak resistances allow the grids to assume a normal voltage which is more favorable for amplifying purposes. The leak resistances allow any accumulated charge on the grids to leak off to the filaments. Still better amplification and quieter operation was produced by

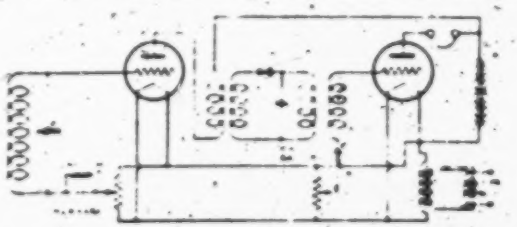


Fig. 3 Two-Stage Amplifier Using Crystal Detector With grid condenser for radio stages and grid batteries for audio stages

replacing the series grid condenser and leak in the audio stage with a 10-volt battery giving a negative charge to the grid. A battery of dry cells was used for this purpose; since only an extremely small current is required, the life of the dry cells is practically their shelf life. This gave a circuit as shown in Fig. 3.

Alternating current rectified by means of a gas-filled two-element rectifier tube a "Tungar" tube was tried as a source of filament power but the residual hum was much greater than when unrectified alternating current was used. This is because of the fact that during rectification, the wave form becomes distorted and it becomes impossible to stabilize the grid voltage by means of the balancing resistances.

607

In the above-mentioned tests, a plate battery was used for convenience, but this was replaced by alternating current which had been rectified by means of an electron tube and smoothed out with condensers of large capacity. The rectification circuit for the plate voltage supply is shown in Fig. 4.

In Fig. 4, the primary P of the transformer T is connected to the power mains, and winding R gives 8 volts for the filament of the rectifier tube W. Winding S gives 300 volts which is rectified by the tube W and smoothed out by the condenser Q, which has about 10 microfarads capacity. This gives at terminals M and N a high-voltage direct current which is quite suitable for use on the plates of the amplifier tubes. Rheostat Z varies the brilliancy of the filament of the rectifier tube and, simultaneously, the voltage for the plates.

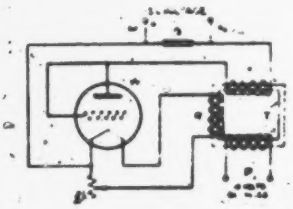


FIG. 4 RECTIFICATION CIRCUIT FOR PLATE VOLTAGE SUPPLY

The use of a loud-speaking telephone receiver such as the "Magnavox" was made possible by applying to the field coil of the loud speaker an alternating current rectified by a "Tungar" rectifier tube. The impedance of the field coil was sufficient to smooth out the pulsating current to such an extent that the hum was not annoying. It was also advantageous to couple the loud-speaking reproducer circuit to the plate circuit of the last amplifier tube by means of a one-to-one ratio telephone transformer with a 0.02-microfarad condenser in series with the telephone circuit. This helped considerably to reduce the residual hum in the telephones.

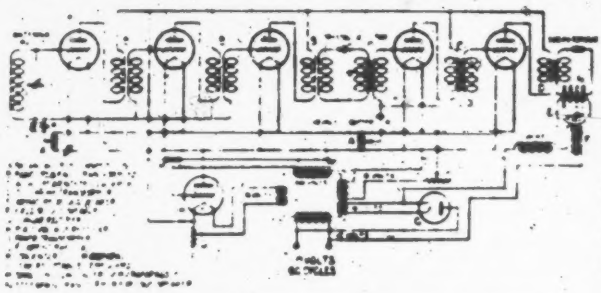


FIG. 5 FINAL COMPLETE CIRCUIT OF FIVE-STAGE AMPLIFIER USING CRYSTAL DETECTOR

Using 60-cycle alternating current to supply power for the filaments and plates

The final circuit is shown in Fig. 5, and includes three stages of radio-frequency amplification, galena crystal detector, two stages of audio-frequency amplification, loud-speaking reproducer, and the necessary power transformer and rectification circuits.

This final circuit gives good amplification, with a slight residual hum which is not great enough to be objectionable when receiving signals of ordinary readable strength. The residual hum is of course more objectionable when extremely weak signals are being received. Radiotelephone music and conversation are clearly reproduced.

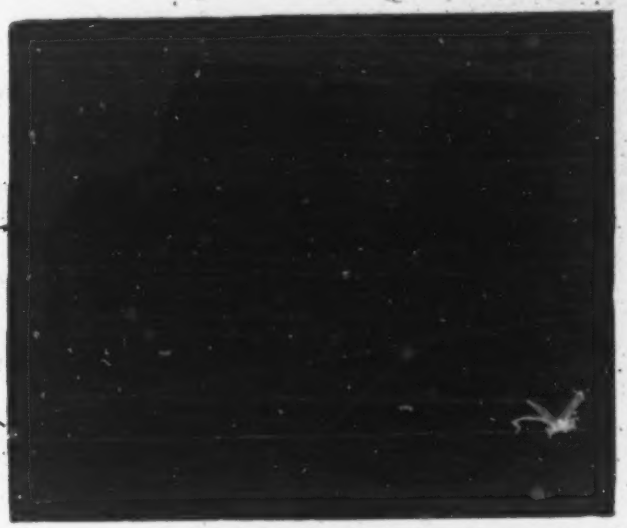


FIG. 6 ASSEMBLED RECTIFIER AND AMPLIFIER UNITS

The amplifier was operated under normal conditions using the usual sources of direct-current supply, and then switched over to alternating-current supply. This comparative test showed the a-c. supply to give as good amplification as the d-c. supply.

For the reception of damped waves, the amplifier as constructed operated most satisfactorily for frequencies from 400 kilocycles to 1500 kilocycles per second (750 to 200 meters). This frequency range was determined by the working range of the radio-frequency transformers used. By using suitable radio-frequency transformers, it is expected that the amplifier will be effective for the reception of damped waves for frequencies as low as 30 kilocycles (10,000 meters). This amplifier has also been found effective for the reception of undamped waves, when used with a separate heterodyne.

The special transformer with five windings and the rectifier tube were assembled in one box, and the amplifier tubes and amplifier transformers and other apparatus were assembled in a separate box. This was done to avoid having the amplifier immediately adjacent to the special transformer, from which it would pick up considerable 60-cycle hum. The assembled rectifier unit measured about 8 in. by 8 in. by 9 in. and weighed about 21 pounds. The assembled amplifier unit measured about 8 in. by 11 in. by 14 in. and weighed about 21 pounds.

Fig. 6 shows the rectifier unit and the amplifier unit as completed, with the plug to connect with the 60-cycle lighting current. A six-inch rule is shown leaning against the rectifier unit.

Mr. F. W. Dunmore was a coworker and participated in the development of this instrument. The author wishes to acknowledge his indebtedness to Mr. R. S. Ould for helpful suggestions in preparing this paper.

PLAINTIFFS' EXHIBIT NO. 21, SHEET 10, 233—
(Radio for September 1922, Page 27.). 234

An Amplifier with A. C. Filament and Plate Supply

By P. D. Lowell

Associate Physicist Bureau of Standards. Adapted from July, 1922, A. I. E. E. Journal

WHEN an electron tube is used as the detector with a. c. supply, ... is impressed on both the plate and filament a 60-cycle hum which, although small, becomes very objectionable when amplified by one or two stages of audio-frequency amplification. When a crystal detector is used with ... frequency tube amplifier no 60-... voltage is supplied to the detector ... t. The radio-frequency transformer whose output is delivered to the ... tor circuit prevents the passage in ... ppreciable amount of 60-cycle current supplied to the radio-frequency ... and such voltages are not present ... the crystal detector circuit and do ... reach the input of the audio-frequency stage.

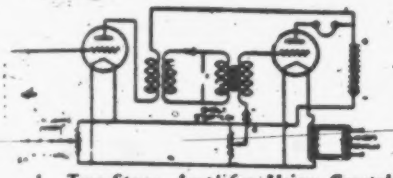


Fig. 1. Two-Stage Amplifier Using Crystal Detector

The employment of a crystal detector ... at first seem objectionable, since ... th the crystal as ordinarily used, it is ... ther difficult to find a point of good ... nsitivity. But tests on this amplifier ... ow that careful adjustment of the ... stal detector is not necessary, because ... radio-frequency amplification pre... the detector usually gives sufficient signal strength, so that a point of sufficient sensitivity can be easily found. This circuit, as shown in Fig. 1, gives ... te good results. The 60-cycle hum ... practically eliminated and the crystal ... tector gives almost as good rectification as the tube detector. It is found ... at better amplifying action can be ... tained by inserting condensers of about ... 02 microfarad capacity, shunted by ... megohm grid leak resistances in the ... d circuits, in series with the sliders ... the balancing resistances. The grid ... ondensers and grid leak resistances al... the grids to assume a normal volt... ge which is more favorable for ampli... ing purposes. The leak resistances allow any accumulated charge on the grids to leak off to the filaments.

Still better amplification and quieter operation was produced by replacing the series grid condenser and leak in the audio stage with a 10-volt battery giving a negative charge to the grid. A battery of dry cells was used for this purpose; since only an extremely small current is required, the life of the dry cells is practically their shelf life. This gave a circuit as shown in Fig. 2.

Alternating current rectified by means of a gas-filled two-element rectifier tube (a "Tungar") was tried as a source of filament power, but the residual hum was much greater than when unrectified alternating current was used. This is because of the fact that during rectification the wave form becomes distorted and it becomes impossible to stabilize the grid voltage by means of the balancing resistances.

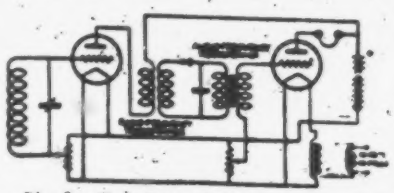


Fig. 2. Two-Stage Amplifier Using Crystal Detector with Grid Condenser for Radio Stages and Grid Battery for Audio Stages.

In the above-mentioned tests a plate battery was used for convenience, but this was replaced by alternating current, which had been rectified by means of an electron tube and smoothed out with condensers of large capacity. The rectification circuit for the plate voltage supply is shown in Fig. 3.

In Fig. 3 the primary P of the transformer *T* is connected to the power mains, and winding *R* gives 8 volts for the filament of the rectifier tube *W*. Winding *S* gives 300 volts, which is rectified by the tube *W* and smoothed out by the condenser *Q*, which has about 10 microfarads capacity. This gives at terminals *M* and *N* a high-voltage direct current, which is quite suitable for use on the plates of the amplifier tubes. Rheostat *Z* varies the brilliancy of the filament of the rectifier tube and, simultaneously, the voltage for the plates.

The use of a loud-speaking telephone receiver, such as the "Magnavox," was made possible by applying to the field coil of the loud speaker an alternating current rectified by a "Tungar" rectifier tube. The impedance of the field coil was sufficient to smooth out the pulsating current to such an extent that the hum was not annoying. It was also advantageous to couple the loud-speaking reproducer circuit to the plate circuit of the last amplifier tube by means of a one-to-one ratio telephone transformer with a 0.02-microfarad condenser in series with the telephone circuit. This helped considerably to reduce the residual hum in the telephones.

The final circuit is shown in Fig. 4, and included three stages of radio-frequency amplification, loud-speaking reproducer, and the necessary power transformer and rectification circuits.

This final circuit gives good amplification, with a slight residual hum which is not great enough to be objectionable

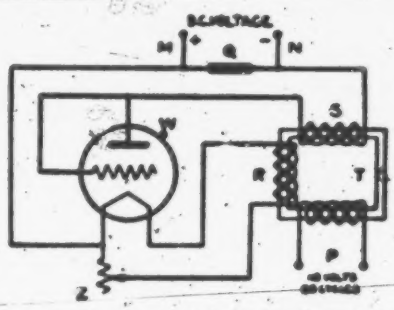


Fig. 3. Rectification Circuit for Plate Volt... Supply

when receiving signals of ordinary readable strength. The residual hum is, of course, more objectionable when extremely weak signals are being received. Radiotelephone music and conversation are clearly reproduced.

The amplifier was operated under normal conditions, using the usual

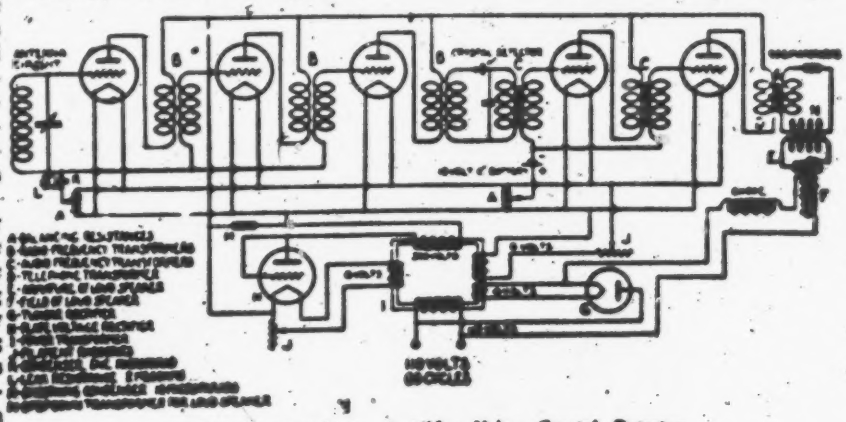


Fig. 4. Five-Stage Amplifier Using Crystal Detector

PLAINTIFFS' EXHIBIT NO. 21, SHEET 11,
28 (Radio for September, 1922, Page 28)

sources of direct-current supply, and then switched over to alternating-current supply. This comparative test showed the a.-c. supply to give as good amplification as the d.-c. supply.

For the reception of damped waves, the amplifier as constructed operated most satisfactorily for frequencies from 400 kilocycles to 1500 kilocycles per second (750 to 200 meters). This frequency range was determined by the working range of the radio-frequency transformers used. By using suitable radio-frequency transformers, it is expected that the amplifier will be effective for the reception of damped waves for frequencies as low as 30 kilocycles (10,000 meters). This amplifier has also been found effective for the reception of undamped waves when used with a separate heterodyne.

The special transformer with five windings and the rectifier tube were assembled in one box, and the amplifier tubes and amplifier transformers and other apparatus were assembled in a separate box. This was done to avoid having the amplifier immediately adjacent to the special transformer, from which it would pick up considerable 60-cycle hum. The assembled rectifier unit measured about 8 in. by 9 in. and weighed about 21 pounds. The assembled amplifier unit measured about 8 in. by 11 in. by 14 in. and weighed about 21 pounds.

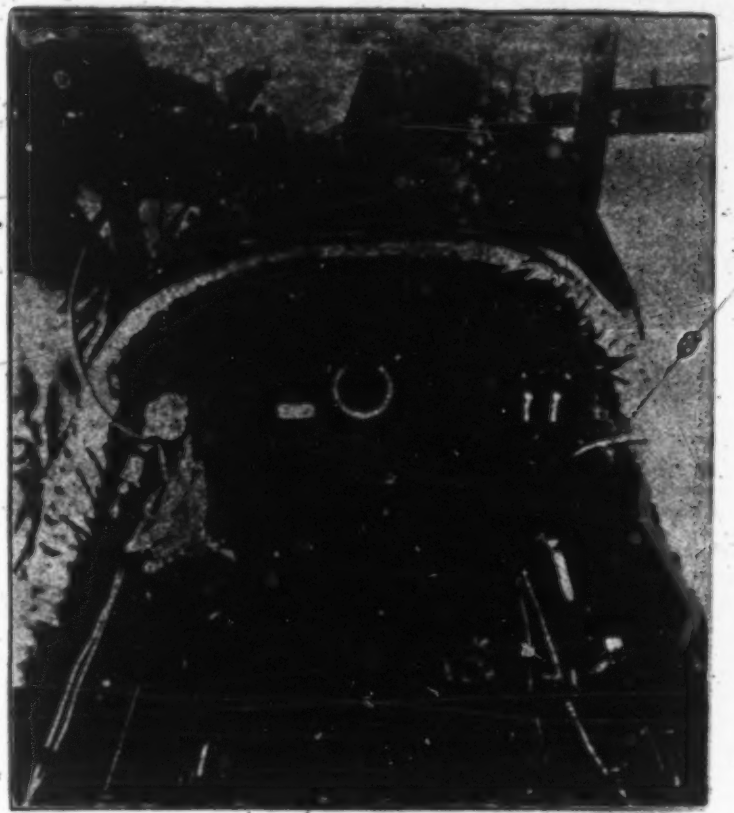
DUPLEX RADIO-TELEPHONE SYSTEM ON AIRCRAFT

By S. R. WINTERS

The transmission and reception of radio-telephone messages simultaneously from aircraft in flight are possible by an arrangement recently devised by the Air Service of the United States Army. Heretofore wireless installations on air-going machines have been primarily for the purpose of receiving messages. It was in this capacity that radio-equipped aircraft were so useful in scouting over enemy-occupied territory in the recent World War.

The twofold service—transmitting and receiving—afforded by recent installations of specially-designed radio-telephone outfits is known as the duplex system. Two electric generators are employed, with the introduction of a new change-over switch, which obviates the use of several instruments heretofore installed with the conventional installation of SCR-73 set. Two antennas are required, one for the transmitting and one for the radio-telephone receiver, but the sending and reception of music or vocal speech can be negotiated at the same instant.

Preliminary tests of aircraft thus equipped have been conducted, the results at reasonable distances being satisfactory. Long-range tests have not been made as yet, although it is probable that this duplex system may demonstrate its efficiency when subjected to distant assignments. Already music has been successfully relayed from a radio-telephone on the ground to aircraft soaring 4000 ft. in the air.



Installation of Radio Set on DH4

Official Photograph U. S. Army Air Service Photographic Section

ARMY AIRSHIP SETS

Army plans for new radio sets for their semi-rigid airships call for central power stations which would include generators geared to gasoline engines, after the fashion in which a magneto is driven, but never before attempted. The French tried out belt-driven electrical generators, but with little success. However, representatives of the Air Service Engineering Department at McCook Field expect to develop a central power plant that will give sufficient power for putting ½ kw. in the antenna and also power for lighting, heat and electrical control work.

The Army Air Service plans to use the new Signal Corps set 135, combining radiophone and telegraph circuits good for distances up to 75 miles and 200 miles, respectively. The range will be greater than is planned for the big Martin bombers, however, as better facilities for erecting aerials are available on airships than on planes. One method considered is to install the antenna within the envelope; another is to suspend it below the ship, drawing it up upon landing; while a third contemplates hanging the wires of the aerial along the sides and over the top of the ship. Experiments will determine which of these methods is the most efficient.

Naval radio experts are loath to reveal their definite plans for the radio equipment of the ZR ships, but it is said that they may parallel the Army's ideas, although their ships will be about twice the size of the largest Army semi-rigids now planned, giving them greater latitude and more room for equipment.

TUBES NOW AVAILABLE FOR SHIPS

F. P. Guthrie, head of the Radio Division of the Shipping Board, states that all privately owned ships, as well as Government operated vessels, may now be equipped with a special receiving tube which will be produced by the Radio Corporation to sell for $10 each. The tubes, which can also be used for amplifying and transmitting, will be a big improvement over the crystal detectors and spark transmitting sets now in use. Heretofore the Radio Corporation has refused to sell its tubes except to amateurs and for experimental use.

[fols. 237 & 238] PLAINTIFFS' EXHIBIT No. 21, SHEET 12

(Telephone—Sept. 16, 1922, page 21)

(Omitted here—See sheet 16 of this Exhibit on page 245.)

Much not the Rally-Switch deep, and doth not the Kat of T.D.M. scratch most woefully? And many men fell on both sides and for a time the Amateurs did not prosper since they were few in number against the great host of the Amalekites arrayed against them.

Then spake the Great Antennius, Chief of Radio, unto his Traffic Manager and said unto him, "Put thou it into the hearts of mine earthly agents, the Department of Commerce, to help these struggling Amateurs against this plague which I in my folly have laid upon them, by laws which shall wisely and justly control these broadcasting stations. Put thou it also into the hearts of the Amateurs that they must refrain from pounding upon their keys during the first watch of the night since it is evident that the listeners, it matteth not how nutty, must also have their time."

And it was so. The earthly agents of the Great Antennius did wisely and justly control the Broadcasting Stations and the Amateurs did stand by (and some even enjoy the concerts) during the first watch and then after most of the listeners were tucked in their beds, traffic flowed as usual during the rest of the night watches although there still remained some misguided persons on both sides who stubbornly maintained that the other belongeth entirely to them. But the Great and Terrible Wouff-Hong that squelcheth all things evil will surely squelch them in time—so wherefore worry? And as runneth the prophesy from NAA in the noontide watch—"The indications are for generally fair weather throughout the United States except for scattered thunder storms in some portions."

More omnia vincit—which meaneth in the language of the Ancient Men of Latium, "Long live Amateur Radio!"

Amplifier Operation from A.C. Supply

By P. D. Lowell*

For years we have been looking forward to the day when we could operate our tube equipment from the A.C. house-lighting supply. Early attempts in this direction were not very encouraging, the resultant hum ranging in many instances into ear-splitting ear-ruption. Recently, however, considerable progress has been made towards a solution and it is safe to assume that the day of its perfection is not far removed. In this article, reprinted from the *July* issue of the *Journal* of the American Institute of Electrical Engineers with the kind permission of the Institute, Mr. Lowell describes the latest known progress in America in this direction.—Editor.

ELECTRON tube amplifiers now form an important part of practically all radio receiving sets, except the most simple types. Such amplifiers are in fact necessary to receive distant stations, or when using coil antennas. For good operation, amplifier tubes require for the filament a source of voltage of very constant value (usually about 6 volts) and for the plate a source of voltage of from 60 to perhaps 300 volts. The filament voltage is usually supplied by storage cells, and the plate voltage by dry cells. The maintenance of these cells in operating condition, especially the storage cells, is often a source of much difficulty and annoyance. The storage cells are necessarily bulky and heavy, require constant attention to maintain proper charge and density of electrolyte, give of injurious acid or other fumes, and are subject to considerable variations of voltage during the period of discharge. The development of an amplifier which can be supplied from the ordinary 110-volt, a-c. lighting mains is of considerable practical importance, since it would eliminate the practical difficulties of maintaining storage cells. The amplifier using such a-c. supply has the important advantages of reliability, convenience, and cheapness both in first cost and operating cost.

Such an amplifier using five stages of amplification has been developed at the Bureau of Standards. There are three

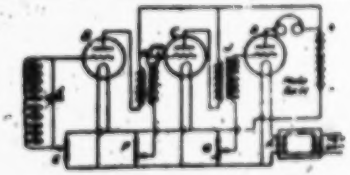


Fig. 1 Two-Stage Amplifier Circuit, using Tube Detector

stages of radio-frequency amplification and two stages of audio-frequency amplification. It is the purpose of this note to describe briefly this amplifier.

The first arrangement tried consisted of one radio-frequency stage of amplification, detector and one audio-frequency stage. The filaments of the three tubes were lighted by 6 volts supplied by a step-down transformer, the primary of which was connected to the 110-volt, 60-cycle power mains. The circuit is shown in Fig. 1.

In Fig. 1, the filament lighting transformer is shown at *A*, supplying voltage for the filaments of electron tubes *B*, *C* and *D*. The amplifier input circuit is connected to the grid of tube *B* and to the slider of the balancing resistance *E*, the latter having a resistance of 200 ohms and being connected across the filament line. A radio-frequency transformer is shown at *H*, a balancing resistance at *F*, an audio-frequency transformer at *J*, and another balancing resistance at *G*. The purpose of the balancing resistances *E*, *F*, *G*, is to keep the normal voltage of the grids at a steady value with respect to the average voltage of the electrical midpoint of the filament so that to eliminate the hum which variations of the grid voltage would cause. These balancing resistances are adjusted until the hum is eliminated. Reception was accomplished with this circuit but there was considerable 60-cycle hum present in spite of the beneficial effect of the balancing resistances.

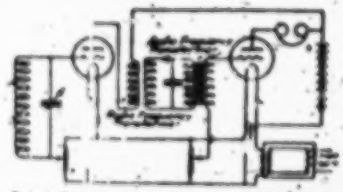


Fig. 2 Two Stage Amplifier using Crystal Detector

The employment of a crystal detector in place of the electron-tube detector reduced the 60-cycle hum very considerably. This circuit is shown in Fig. 2.

When an electron tube is used as the detector, there is impressed on both the plate and the filament a 60-cycle a-c. voltage which, although small, becomes very objectionable when amplified by one or two stages of audio-frequency amplification. When the crystal detector is used, no 60-cycle voltage is supplied to the detector circuit. The radio-frequency transformer whose output is delivered to the detector circuit prevents the passage in any appreciable amount of 60-cycle current supplied to the radio-frequency stage, and such voltages are not present in the crystal detector circuit and do not reach the input of the audio frequency stage.

The employment of a crystal detector may at first seem objectionable, since with the crystal as ordinarily used it is rather difficult to find a point of good sensitivity. But tests on this amplifier showed that a careful adjustment of the crystal detector was not necessary because the radio-frequency amplification preceding the detector usually gave sufficient signal strength so that a point of sufficient sensitivity could be easily found.

This circuit gave quite good results. The 60-cycle hum was practically eliminated and the crystal detector gave almost as good rectification as the tube detector.

It was found that better amplifying

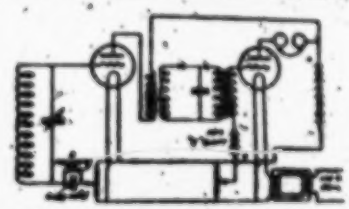


Fig. 3 Two-Stage Amplifier using Crystal Detector, with grid condensers for audio stages and grid battery for audio stages

action could be obtained by inserting condensers of about 0.01 microfarad capacity, shunted by 5-megohm grid leak resistances, in the grid circuits, in series with the sliders of the balancing resistances. The grid condensers and grid leak resistances allow the grids to assume a normal voltage which is more favorable for amplifying purposes. The leak resistances allow any accumulated charge on the grids to leak off to the filaments. Still better amplification and quieter operation was produced by replacing the series grid condenser and leak in the audio stage with a 10 volt battery giving a negative charge to the grid. A battery of dry cells was used for this purpose; since only an extremely small current is required, the life of the dry cells is practically their shelf life. This gave a circuit as shown in Fig. 3.

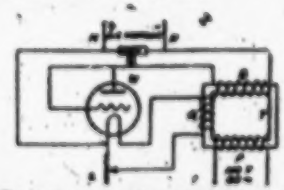


Fig. 4 Rectifier Circuit for Plate Voltage Supply

Alternating current rectified by means of a gas-filled two-element rectifier tube (a "Tungar" tube) was tried as a source of filament power but the residual hum was much greater than when unrectified alter-

PLAINTIFFS' EXHIBIT NO. 21, SHEET 13,
(Q.S.T. Oct., 1922, Pages 32 and 33)
239-240
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nating current was used. This is because of the fact that during rectification, the wave form becomes distorted and it becomes impossible to stabilize the grid voltage by means of the balancing resistances.

In the above mentioned tests, a plate battery was used for convenience, but this was replaced by alternating current which had been rectified by means of an electron tube and smoothed out with condensers of large capacity. The rectification circuit for the plate voltage supply is shown in Fig. 4.

In Fig. 4 the primary *P* of the transformer *T* is connected to the power mains, and winding *R* gives 8 volts for the filament of the rectifier tube *W*. Winding *S* gives 300 volts which is rectified by the tube *W* and smoothed out by the condenser *Q*, which has about 10 microfarads capacity. This gives at terminals *M* and *N* a high-voltage direct current which is quite suitable for use on the plates of the amplifier tubes. Rheostat *X* varies the brilliancy of the filament of the rectifier tube and, simultaneously, the voltage for the plates.

The use of a loud-speaking telephone receiver such as the "Magnavox" was made possible by applying to the field coil of the loud speaker an alternating current rectified by a "Tungar" rectifier tube. The impedance of the field coil was sufficient to smooth out the pulsating current to such an extent that the hum was not annoying. It was also advantageous to couple the loud-speaking reproducer circuit to the plate circuit of the last amplifier tube by means of a one-to-one ratio telephone transformer with a 0.02-microfarad condenser in series with the telephone circuit. This helped considerably to reduce the residual hum in the telephones.

The final circuit is shown in Fig. 5, and includes three stages of radio-frequency amplification, galena crystal detector, two stages of audio-frequency amplification, loud-speaking reproducer, and the necessary power transformer and rectifying circuits.

This final circuit gives good amplification, with a slight residual hum which is not great enough to be objectionable when receiving signals of ordinary readable strength. The residual hum is of course more objectionable when extremely weak signals are being received. Radio telephone music and conversation are clearly reproduced.

The amplifier was operated under normal conditions using the usual sources of direct-current supply, and then switched over to alternating-current supply. This comparative test showed the a-c supply to give as good amplification as the d-c. supply.

For the reception of damped waves, the amplifier as constructed operated most satisfactorily for frequencies from 400 kilocycles to 1500 kilocycles per second (750 to 200 meters). This frequency range was determined by the working range of the radio-frequency transformers used. By using suitable radio-frequency transformers, it is expected that the amplifier will be effective for the reception of damped waves for frequencies as low as 30 kilocycles (10,000 meters). This amplifier has also been found effective for the reception of undamped waves, when used with a separate heterodyne.

The special transformer with five windings and the rectifier tube were assembled in one box, and the amplifier tubes and amplifier transformers and other apparatus were assembled in a separate box. This was done to avoid having the amplifier immediately adjacent to the special transformer, from which it would pick up considerable 60-cycle hum. The assembled rectifier unit measured about 8 in. by 8 in. by 9 in. and weighed about 21 pounds. The assembled amplifier unit measured about 8 in. by 11 in. by 14 in. and weighed about 21 pounds.

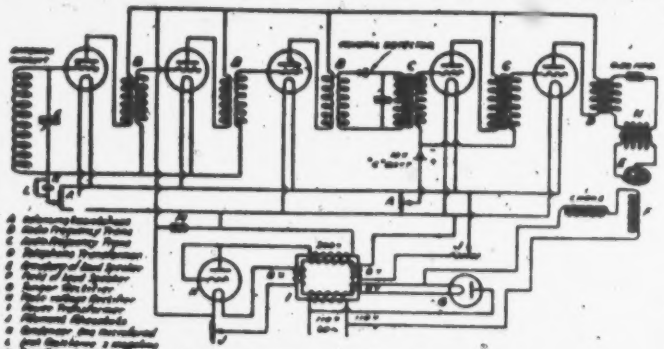

Fig 5 Final Complete Circuit of Five-Stage Amplifier using Crystal Detector using 60 cycle alternating current to supply power for the filaments and plates.

Mr. F. W. Dunmore was a co-worker and participated in the development of this instrument. The author wishes to acknowledge his indebtedness to Mr. E. E. Bucher for helpful suggestions in preparing this paper.

A Week in Baltimore With Portable Station 3OI

By John Evans, jr., 3AQG

At the June meeting of the Chester County Radio Association, Yours Truly was resting easy after making a report that the association had at the present time over 125 members and was growing. Then out of a clear sky the meeting was informed that 3OI was to go to Baltimore for the week of June 10-15th inclusive, to be placed in the Fifth Regiment Armory under the auspices of the Maryland Radio Association for participation in the Export and Import Exposition to be held there on those dates.

Several days later a phone message from headquarters took me to Parkesburg and after two weeks of work which included painting, scrubbing, wiring, testing, etc., portable station 3OI hit the roads for Baltimore, at 10:10 A.M. Saturday, July 8th. Four miles of dusty road put a coat of tan on the sturdy shack. Everything went well until Nottingham, Pa., was slightly in the distance, then the engine on the truck refused to percolate. We found the gasoline feed to the carburetor broken completely off. The sun was shining brightly and, take it or leave it, it was some walk up the pike to the nearest garage. After three precious hours of tinkering we started off again.

It might be well to mention right here that the truck from the ground to the top of the shack measures 13 feet 6 inches, which necessitated careful watch on limbs of trees and other things overhead. At Gilpin Falls, Md., we encountered a covered bridge, which took off a piece of our roof. Everything went fairly well but of course slowly until we landed in Baltimore about 12:30 A.M. Sunday.

Our directions were anything but specific and after traveling up and down Charles and Gay Streets several times, we found a haven in the Central Police Station, where a pay-telephone was our only hope. After making a dozen calls I found it was impossible to get the truck into the Armory that night. Then after making a round of the city and looking over fifteen or more garages we finally found one to accommodate her height and parked her for the night. The driver and I then found a hotel and hit the hay for a much needed rest.

In the morning on going to the Armory we were cordially met by the Third District Council President, Mr. E. E. Bucher, who was so anxious to see 3OI again and her in the booth that we had to go to the garage at once and bring her around to the Armory. More hard luck awaited us. We found that the clearance of the Armory door was not sufficient for her to get in. Since a cottage on wheels will not shrink as easily as a radio man's pocketbook, it was necessary for us to get riggers to remove the house from the chassis and put it in position on the Armory floor. This feat took practically all day Sunday.

On Monday morning I took up the task of putting the batteries and other paraphernalia together, also had the house cleaned inside and outside. Monday seemed to speed along and when the Exposition opened at 7:00 P.M. everything was in readiness and the crowd eagerly awaited the first selection from our radiophone transmitter.

I will state here that the Hall was well supplied with radio receiving apparatus. All of the stations excepting one were equipped with Magnavox reproducing devices, and the other one had a real Western Electric loud speaker that barked a message that was echoed and re-echoed throughout the Armory.

The transmitting equipment in 3OI includes a 20-watt DeForest transmitter which is used for key work and a special two ½-watt tube radiophone transmitter (3ZO-built) employing the Appleby-Heising modulating scheme. This set was driven by either 420 volts storage battery or a 500 volt motor generator, and was the set which was used practically all of the time we were in Baltimore.

The interest of the crowd seemed to center about 3OI—no doubt because it is something the public rarely sees—a radio broadcasting station in full operation; also because of the careful designing of the apparatus and the well-arranged interior of the station. In order to estimate the number of visitors who came into the station on Friday night we asked them to sign their names in a book. This book is now

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244

Radio News for September, 1922

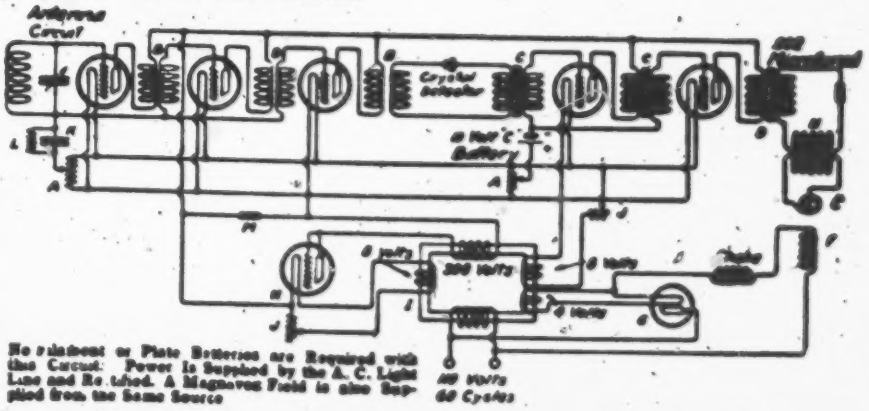
Discarding Storage Batteries

By S. R. WINTERS

THE unwieldy storage battery, heretofore considered an integral part of radiotelephone receiving apparatus, may be discarded in the future and another source of electric current tapped effectively. An electron-tube amplifier, employing a 60-cycle alternating current in supplying impulses to both filaments and plates of the vacuum tubes, has been designed by P. D. Lowell of the Radio Communication Section of the Bureau of Standards, United States Department of Commerce. Elimination of storage batteries is possible by forming contact with a common electric-lamp socket.

The newly-designed amplifier, in the absence of which the use of storage batteries is not obviated, is provided with three stages of radio-frequency and two of audio-frequency. A crystal detector is used in this system instead of an electron-tube detector. Amplification derived from the use of an alternating electric current is quite as effective as when direct current is employed. The complete outfit for the reception of radio-telephone communications is compactly built and may be readily transported from one place to another. The experimental unit, as originally designed by the Radio-Communication Section of the Bureau of Standards, operates effectively when adjusted to wave-lengths ranging from 200 to 750 meters. These wave-length restrictions can be removed or expanded by the application of suitable radio-frequency transformers. The new amplifier may be used with any type of antenna.

The distracting hum or the din of noise from alternating electric current when substituting for storage batteries in previous experimental efforts to discard the latter has been the bane of all such attempts. The system evolved by the Bureau of Standards, if we are to accept the usual conservative claims of this government department, has



No Filament or Plate Batteries are Required with this Circuit. Power is Supplied by the A. C. Light Line and Rectified. A Magnavox Field is also Supplied from the Same Source

been reduced to a minimum. The humming noise in the final analysis is not distracting. To accomplish this end, wireless amateurs who may attempt to duplicate the amplifier conceived by this government bureau, will find it necessary to manipulate a larger number of adjustments than when employing a conventional amplifier, whose source of strength is the storage battery.

A 60-cycle alternating current when applied to the service of an ordinary amplifying circuit introduces such a robust note in the telephone receivers as to render reception impossible. This condition, in the system being described, is well-nigh obviated by an arrangement involving the use of balancing resistances, grid condensers, and special grid-leaks of relatively low resistance, telephone transformer in the output circuit, and the employment of a crystal detector instead of a vacuum tube in this capacity.

The newly-conceived electron-tube amplifier, instead of employing a storage battery for lighting the filament and a dry battery as a source of strength for the plate circuit, substitutes therefor a special transformer and an electron-tube rectifier, as well as other accessories. The bulk and weight of these combined units are less than that of storage batteries. A small 10-volt dry battery is used in the grid circuit the obligation imposed on this source of electricity being only to deliver an infinite-simally small current. The life of this battery is reasonably assured for several months. The parts utilized in this electron-tube amplifier in replacement of the storage battery may be obtained at a moderate cost. The specially-designed transformer is the only unit that approaches in financial investment that involved in obtaining a storage battery. The labor of assembling is the outstanding consideration in acquiring this transformer.

Bulkiness, its weight in pounds, the necessity of charging periodically, and the acid contained therein both as a source of danger and damage to household or office, are the items in the bill of indictment preferred against the storage battery. Some individuals would go so far as to issue a blanket indictment against this source of electric strength as being responsible for retarding the unrestrained development of the radio-telephone as a household utility.

The bulkiness and weight of the storage battery, assuredly, have retarded progress in the direction of compactness in portable radio-telephone and radio-telegraph receiving outfits. A striking example in the mind of the writer is a portable wireless set recently developed by the Signal Corps of the United States Army. As now constituted, the apparatus can be strapped on the shoulders of two men and carried afield, irrespective of the rugged conditions encountered. The carriage of the storage batteries involves the services of one person. By the elimination of this cumbersome unit, it would be possible for one man to transport this equipment from place to place.

The electron-tube amplifier described in this article may, or may not, signify the elimination of storage batteries. The Bureau of Standards admits that its progeny is in an experimental stage. Anyway, a start has been made. P. D. Lowell, the inventor of this electron-tube amplifier, has

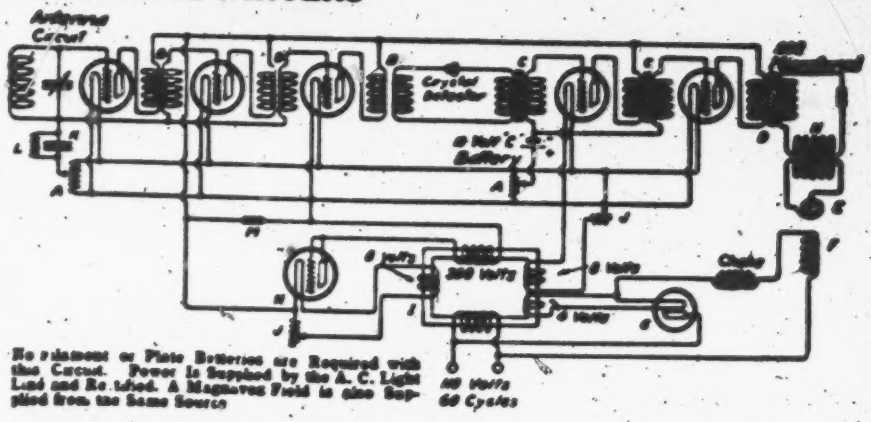
Discarding Storage Batteries

By S. R. WINTERS

THE unwieldy storage battery, heretofore considered an integral part of radiotelephone receiving apparatus, may be discarded in the future and another source of electric current tapped effectively. An electron-tube amplifier, employing a 60-cycle alternating current in supplying impulses to both filaments and plates of the vacuum tubes, has been designed by P. D. Lowell of the Radio Communication Section of the Bureau of Standards, United States Department of Commerce. Elimination of storage batteries is possible by forming contact with a common electric-lamp socket.

The newly-designed amplifier, in the absence of which the use of storage batteries is not obviated, is provided with three stages of radio-frequency and two of audio-frequency. A crystal detector is used in this system instead of an electron-tube detector. Amplification derived from the use of an alternating electric current is quite as effective as when direct current is employed. The complete outfit for the reception of radio-telephone communications is compactly built and may be readily transported from one place to another. The experimental unit as originally designed by the Radio Communication Section of the Bureau of Standards, operates effectively when adjusted to wave-lengths ranging from 200 to 750 meters. These wave-length restrictions can be removed or expanded by the application of suitable radio-frequency transformers. The new amplifier may be used with any type of antenna.

The distracting hum or the din of noise from alternating electric current when substituting for storage batteries in previous experimental efforts to discard the latter has been the bane of all such attempts. The system evolved by the Bureau of Standards, if we are to accept the usual conservative claims of this government department, has



No Filament or Plate Batteries are Required with this Circuit. Power is Supplied by the A. C. Light Line and Rectified. A Magnetron Field is also Supplied from the Same Source

been reduced to a minimum. The humming noise in the final analysis is not distracting. To accomplish this end, wireless amateurs who may attempt to duplicate the amplifier conceived by this government bureau, will find it necessary to manipulate a larger number of adjustments than when employing a conventional amplifier, whose source of strength is the storage battery.

A 60-cycle alternating current when applied to the service of an ordinary amplifying circuit introduces such a robust note in the telephone receivers as to render reception impossible. This condition, in the system being described, is well-nigh obviated by an arrangement involving the use of balancing resistances, grid condensers, and special grid-leaks of relatively low resistance, telephone transformer in the output circuit, and the employment of a crystal detector instead of a vacuum tube in this capacity.

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The electron-tube amplifier described in this article may, or may not, signify the elimination of storage batteries. The Bureau of Standards admits that its progeny is in an experimental stage. Anyway, a start has been made. P. D. Lowell, the inventor of this electron-tube amplifier, has a predilection for designing wireless units neat and compact in formation. He conceived the idea of converting a common suit-case into a complete radio-receiving outfit, which original conception was first described by this writer in RADIO NEWS of September, 1921. "Radio in a Suit-Case," is a phrase that is fascinating and the idea is now being widely translated into reality. The germ of this compact radio formation had its inception with P. D. Lowell of the Radio Section of the Bureau of Standards.

TEXT IS VERY POOR

PLAINTIFFS' EXHIBIT No. 21, Sheet 16
(Telephone- September 16, 1922, Page 21)

245—246

Batteryless Radio Receiving Set

Notes on Electron Tube Amplifier Which Uses 60-Cycle Alternating Current to Supply Power for Filaments and Plates—Paper Giving Circuit Diagrams Published in Journal of the American Institute of Electrical Engineers

By P. D. Lowell,
Associate Physicist, Bureau of Standards

Electron tube amplifiers now form an important part of practically all radio receiving sets, except the most simple types. Such amplifiers are in fact necessary to receive distant stations, or when using coil

For good operation, amplifier tubes require the filament a source of voltage of constant value (usually about 6 volts) and for the plate a source of voltage which is to be changed (90 volts). The filament voltage is usually supplied by storage cells, and the plate voltage by dry

The maintenance of these cells in operating condition, especially the storage cells, is often a source of much difficulty and expense. The storage cells are bulky and heavy, require constant attention to maintain proper charge and specific gravity of electrolyte, give off injurious gases at times, and are subject to wide variations of voltage during a period of discharge.

The development of an amplifier which can be supplied from the ordinary 110-volt 60-cycle alternating current lighting mains is of considerable practical importance, since it would eliminate the practical difficulties of maintaining storage cells. The amplifier using alternating current supply has the great advantages of reliability, economy and cleanliness both in first cost and operating cost.

An amplifier using five stages of amplification has been developed at the Bureau of Standards. There are three stages of radio-frequency amplification and two stages of audio-frequency amplification transformer, the primary of which was connected to the 110-volt, 60-cycle power mains. The circuit is shown in Fig. 1.

In Fig. 1, the filament lighting transformer is shown at *A*, supplying voltage for the filaments of electron tubes *B*, *C*, and *D*. The amplifier input circuit is connected to the grid of tube *B* and to the slider of the balancing resistance *E*, the latter having a resistance of 200 ohms and being connected across the filament line.

A radio-frequency transformer is shown at *H*, a balancing resistance at *F*, an audio-frequency transformer at *J*, and another balancing resistance at *G*. The purpose of the balancing resistances, *E*, *F*, *G*, is to keep the normal voltage of the grids at a steady value with respect to the average voltage of the electrical midpoint of the filament and thus to eliminate the hum which variations of the grid voltage would cause. These balancing resistances are adjusted until the hum is eliminated.

Reception was accomplished with this circuit but there was considerable 60-cycle hum present in spite of the beneficial effect of the balancing resistances.

The employment of a crystal detector in place of the electron tube detector reduced the 60-cycle hum very considerably. This circuit is shown in Fig. 2.

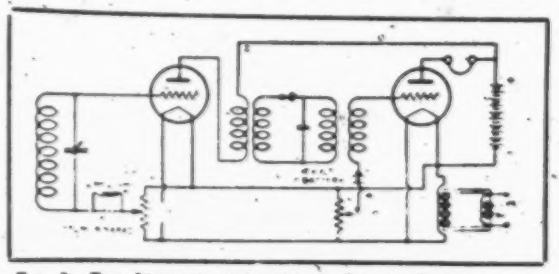


Fig. 3. Two-Stage Amplifier Using Crystal Detector with Grid Condenser for Radio Stages and Grid Battery for Audio Stages.

If no radio-frequency transformer is used, no 60-cycle voltage is supplied to the detector circuit.

The radio-frequency transformer whose output is delivered to the detector circuit prevents the passage in any appreciable amount of 60-cycle current supplied to the radio-frequency stage, and such voltages are not present in the crystal detector circuit and do not react on the input of the audio-frequency stage.

The employment of a crystal detector may at first seem objectionable, since with the crystal as ordinarily used it is rather difficult to find a point of good sensitivity. But tests on the amplifier showed that careful adjustment of the crystal detector was not necessary because the radio-frequency amplification preceding the detector usually gave sufficiently strong signals so that a point of sufficient sensitivity could be easily found.

This circuit gave quite good results. The 60-cycle hum was practically eliminated and the crystal detector gave almost

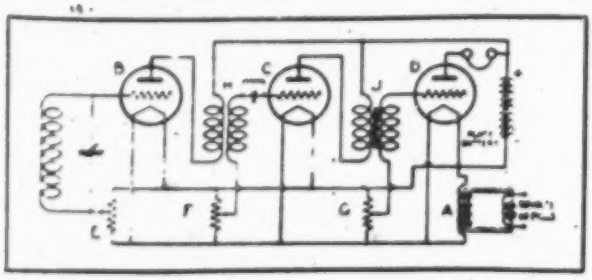


Fig. 1. Two-Stage Amplifier Circuit Using Tube Detector.

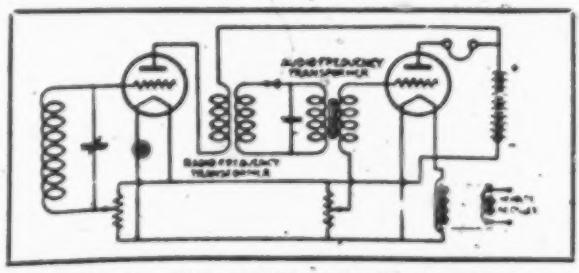


Fig. 2. Two-Stage Amplifier Using Crystal Detector.

It is the purpose of this note to describe briefly this amplifier.

The first arrangement tried consisted of one radio-frequency stage of amplification, one detector and one audio-frequency stage. The filaments of the three tubes were supplied by 6 volts supplied by a step-down

When an electron tube is used as the detector there is impressed on both the plate and the filament a 60-cycle alternating current voltage which, although small, becomes very objectionable when amplified by one or two stages of audio-frequency amplification. When the crystal detector is used there is practically no 60-cycle voltage impressed on the detector, and consequently no 60-cycle hum. The crystal detector also has the advantage that it gives as good rectification as the tube detector.

It was found that better amplification could be obtained by inserting condensers of about 0.02 microfarad capacity, shunted by 2-megohm grid leak resistances, in the grid circuits, in series with the sliders of the balancing resistances.

The grid condensers and grid leak resistances allow the grids to assume a normal voltage which is more favorable for amplifying purposes. The leak resistances allow any accumulated charge on the grids to leak off to the filaments.

Still better amplification and quieter operation was produced by replacing the series grid condenser and leak in the audio stage with a 10-volt battery giving a negative charge to the grid. A battery of dry cells was used for this purpose; since only an extremely small current is required, the life of the dry cells is practically their shelf life. This gave a circuit as shown in Fig. 3.

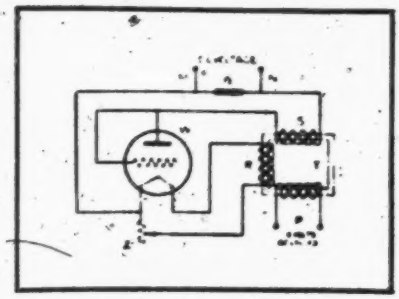


Fig. 4. Rectification Circuit for Plate Voltage Supply.

Alternating current rectified by means of a gas-filled, two-element rectifier tube (a "Tungar" tube) was tried as a source of filament power but the residual hum was much greater than when unrectified alternating current was used. This is because of the fact that during rectification the wave form becomes distorted and it becomes impossible to stabilize the grid voltage by means of the balancing resistances.

In these tests, a plate battery was used for convenience, but this was replaced by alternating current which had been rectified by means of an electron tube and smoothed out with condensers of large capacity. The rectification circuit for the plate voltage supply is shown in Fig. 4.

In Fig. 4, the primary, *P*, of the transformer, *T*, is connected to the power mains, and winding, *F*, gives 8 volts for the filament of the rectifier tube, *R*. Winding *S* gives 300 volts which is rectified by the tube, *R*, and smoothed out by the condenser, *O*, which has about 10 microfarads capacity.

This gives at terminals, *M* and *N*, a high-voltage direct current which is quite suitable for use on the plates of the amplifier tubes. Rheostat *Z* varies the brilliancy of the filament of the rectifier tube and, simultaneously, the voltage for the plates.

The use of a loud-speaking telephone receiver such as the "Magnavox" was made possible by applying to the field coil of the loud speaker an alternating current rectified by a "Tungar" rectifier tube. The impedance of the field coil was sufficient to smooth out the pulsating current to such an extent that the hum was not annoying.

It was also advantageous to couple the loud-speaking reproducer circuit to the plate circuit of the last amplifier tube by means of a one-to-one ratio telephone transformer with a 0.02 microfarad condenser in series with the telephone circuit. This helped considerably to reduce the residual hum in the telephones.

The final circuit is shown in Fig. 5, and includes three stages of radio-frequency amplification, galena crystal detector, two stages of audio-frequency amplification, loud-speaking reproducer, and the necessary power transformer and rectification circuits.

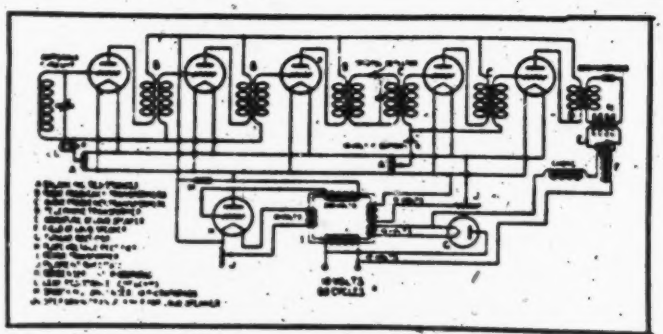


Fig. 5. Final Complete Circuit of Five-Stage Amplifier Using Crystal Detector with 60-Cycle Alternating Current to Supply Power for the Filaments and Plates.

This final circuit gives good amplification, with a slight residual hum which is not great enough to be objectionable when receiving signals of ordinary readable strength. The residual hum is, of course, more objectionable when extremely weak signals are being received. Radiotelephone music and conversation are clearly reproduced.

The amplifier was operated under the usual normal conditions sources of direct-current supply, and then switched over to alternating-current supply. This comparative test showed the alternating-current supply to give as good amplification as the direct-current supply.

For the reception of damped waves the amplifier as constructed operates satisfactorily for frequencies from 10 kilocycles to 1,500 kilocycles per second (750 to 200 meters). This frequency range was determined by the wavelength range of the radio-frequency transformers used.

By using suitable radio-frequency transformers, it is expected that the amplifier will be effective for the reception of damped waves for frequencies as low as 20 kilocycles (15,000 meters). The amplifier has also been found effective for the reception of undamped waves, when used with a separate heterodyne.

The special transformer with five windings and the rectifier tube were assembled in one box, and the amplifier tubes, amplifier transformers and other parts were assembled in a separate box. This was done to avoid having the rectifier immediately adjacent to the audio transformer, from which we would pick up considerable 60-cycle hum.

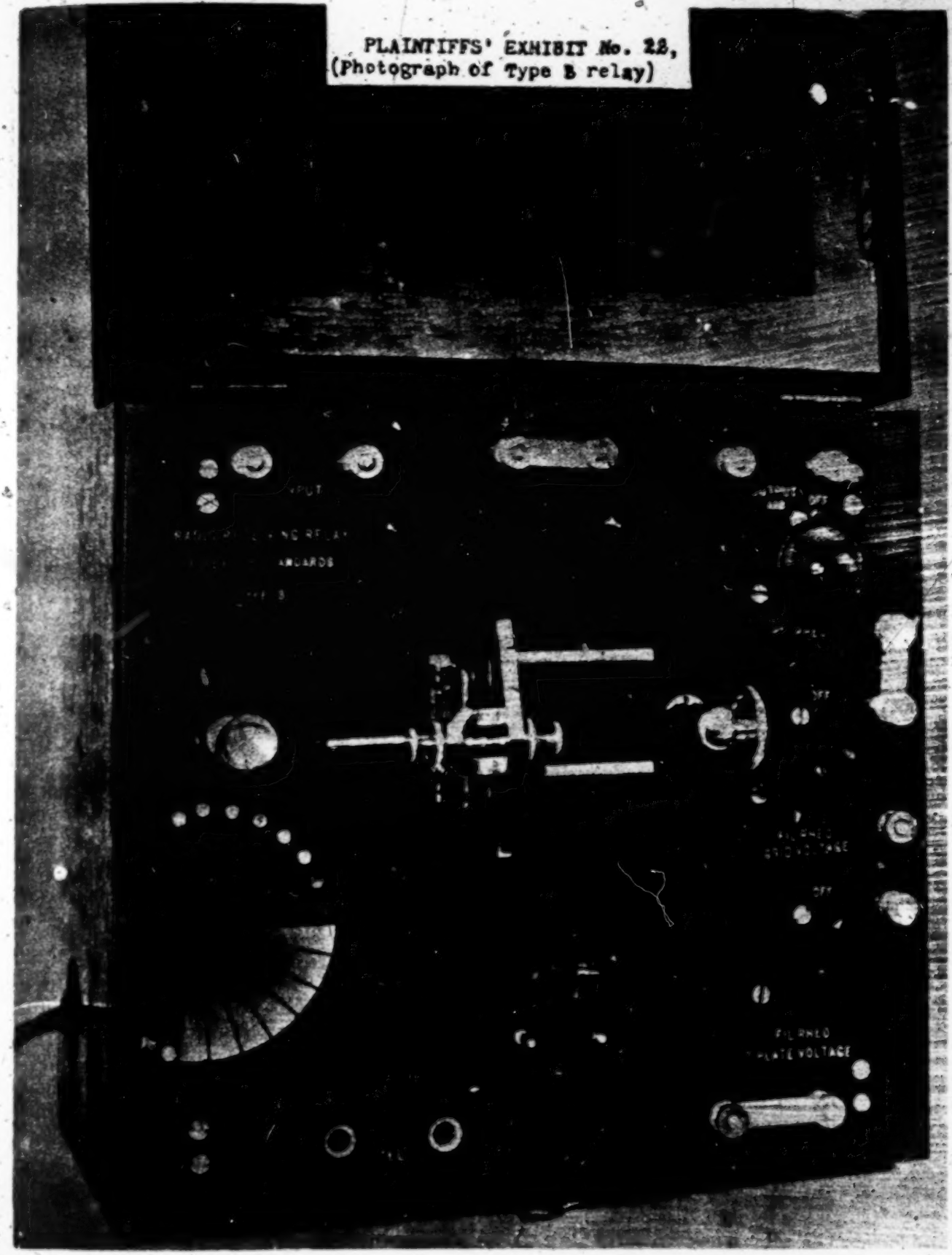
The assembled rectifier unit measured about 8 ins. by 8 ins. by 9 ins. and weighed about 9 pounds. The assembled amplifier unit measured about 8 ins. by 11 ins. by 11 ins. and weighed about 21 pounds.

Fig. 6 shows the rectifier unit and the amplifier unit as assembled, with the plug to connect with the 60-cycle lighting current. A 6-inch rule is shown leaning against the rectifier unit.

F. W. Dunmore was associated with the worker and participated in the development of this instrument. The author is indebted to R. S. Ould for helpful suggestions in preparing this paper.

Fig. 6. Assembled Rectifier and Amplifier Units.

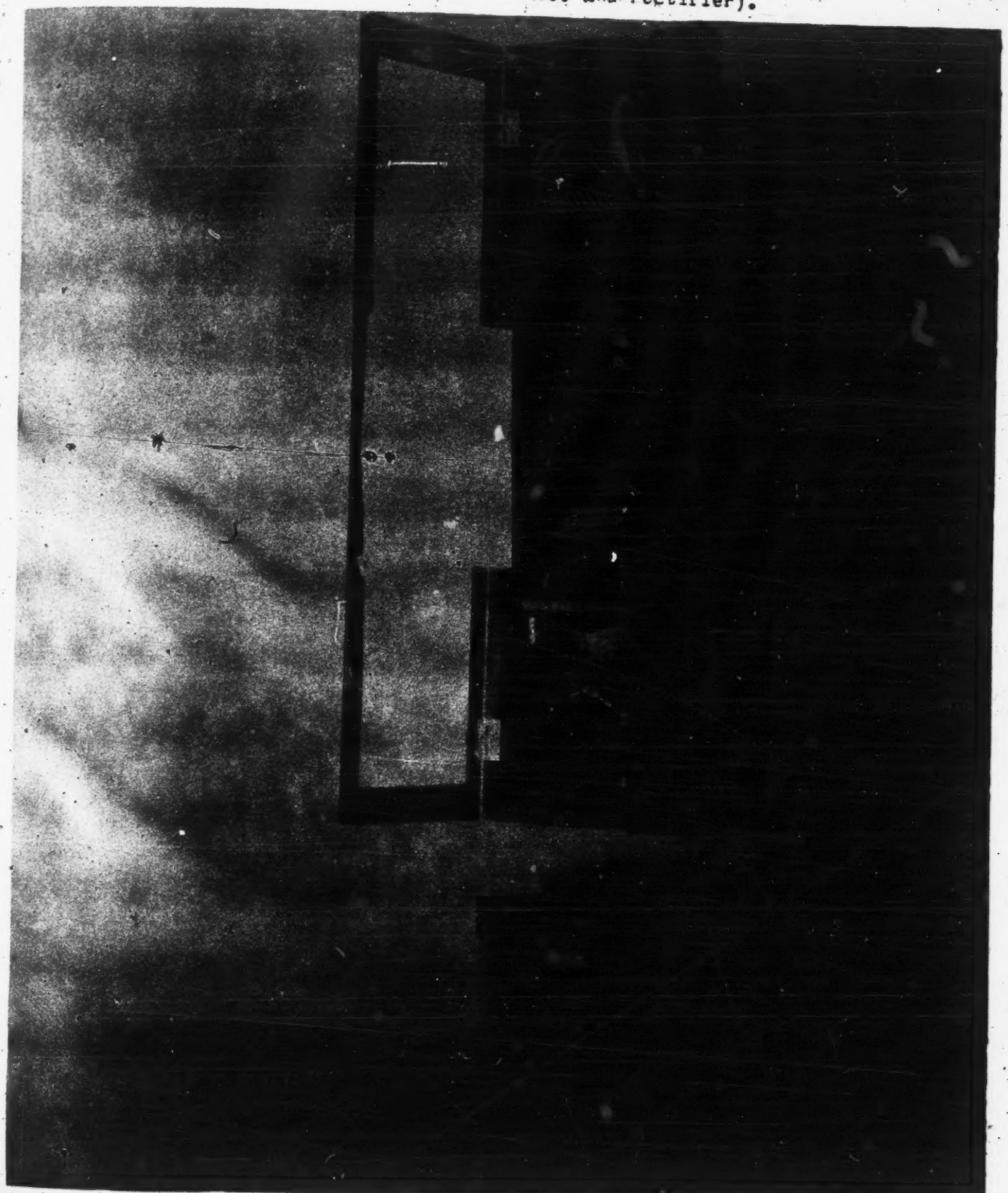
PLAINTIFFS' EXHIBIT No. 22,
(Photograph of Type B relay)



PLAINTIFFS' EXHIBIT NO. 29,
(Photograph of Dunmore's Laboratory at home)

FLAINTIFFS' EXHIBIT No. 47.
(Photograph of Box Type)

PLAINTIFFS' EXHIBIT No. 49, 255-256
(Photograph of Freed-Eisemann Set wired for A.C. and rectifier).



PLAINTIFFS' EXHIBIT No. 50,
(Diagram of Lowell & Dunmore box set)

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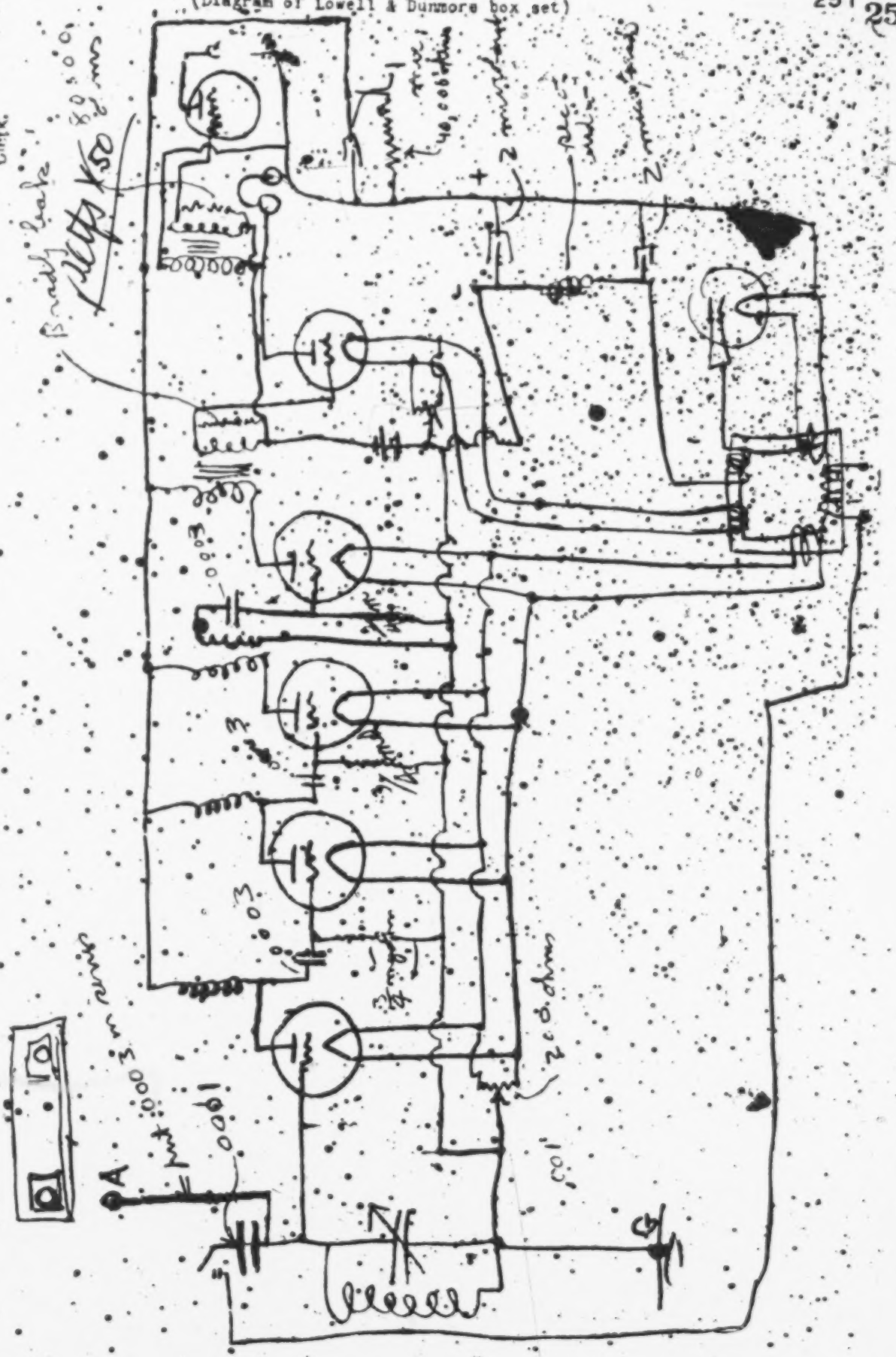
Plaintiffs' Exhibit No. 50

Clerk.


Brady Lake
KSO
40,000 ohms
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PLAINTIFFS' EXHIBIT NO. 53, Sheet 1
(A.I.E.E. Journal, April 1922, page 1.

A Relay Recorder for Remote Control by Radio

Pltfs X53

BY F. W. DUNMORE
Radio Laboratory, Bureau of Standards

Review of the Subject. *Relays have been used for many years in wire telegraphy and other electrical work. The practical operation of relays actuated by received radio signals is a comparatively recent development, and has been made possible by the development of the electron tube amplifier.*

This paper describes the development and the operating principles of a type of relay recorder which is designed to operate from the output terminals of a radio receiving set and which may also be operated by any other source of audio-frequency signal.

By the use of special electron tube circuits the audio-frequency signal is caused to operate an ordinary telegraph relay.

In order to avoid the necessity for using a very sensitive relay, designed to operate on currents of a milliampere or less, which would have delicate adjustments and light contacts and spring tension, advantage was taken of an electron tube amplifier, which has now become a reliable radio instrument, to increase the input voltage to the relay circuit thus making possible the use of a simple ordinary high-resistance telegraph relay. The relay device has therefore been developed to operate from the output circuit of any suitable amplifier in place of the ordinary telephone receivers.

The operation of the relay may serve to work a sounder, buzzer, tape register or any mechanism for remote control by radio.

Two types are described. One type is designed to be operated from batteries. The other type is designed to operate entirely from any 60-cycle 110-volt lighting circuit and this feature makes this type simple and inexpensive to operate, durable and practical. Another unique feature is described which is that of tuning to different audio-frequencies whereby any one of three signals, each of a different audio pitch, may be caused to operate the relay to the exclusion of the others.

Curves and diagrams are shown illustrating the principles of operation.

By the use of two of these relay recorders connected in series across the output terminals of a single radio receiving set, two messages sent on practically the same wave length but of different audio-frequencies, have been accurately received simultaneously.

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Type A—For Use With Batteries
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2. Requirements. (100 w.)
3. Circuit Used. (280 w.)
4. Principle of Operation. (275 w.)
5. Method of Increasing Sensitivity and Selectivity. (275 w.)
6. Speed of Operation. (75 w.)
7. Sensitivity. (100 w.)
8. Durability. (40 w.)
9. Portability. (25 w.)
10. Uses. (230 w.)

Type B—For Use on the 60-Cycle, 110-Volt, A-C. Supply. (320 w.)

Type A— For Use With Batteries

1. *Object of Development.* The object of this investigation was to develop a relay which should operate by received radio signals.

2. *Requirements.* To be satisfactory as a relay recorder the device should have the following characteristics: (1) it must be of simple construction, with few adjustments; (2) it must be easy to adjust and capable of being put into operation quickly; (3) it must be selective and as free from static and such disturbances as possible; (4) it must be capable of operating at a speed of at least 12 times per second; (5) it must respond to weak signals; (6) it must be of strong design, durable and capable of maintaining its adjustments; (7) it must be portable.

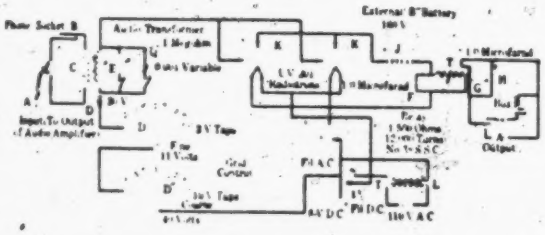

Fig. 1—Circuit Diagram of Relay Recorder for Use with Batteries

3. *Circuit Used.* In order to avoid the use of a very sensitive relay designed to operate on currents of a milliampere or less, with delicate adjustments and light contacts and spring tension, advantage was taken of the radio-audio amplifier (which has now become a reliable radio instrument) to increase the input voltage to the relay circuit, thus making possible the use of a simple ordinary high-resistance telegraph relay. The relay device has therefore been developed to operate from the output circuit of any suitable amplifier in place of the ordinary telephone receivers. The only adjustment necessary is that of an ordinary telegraph relay.

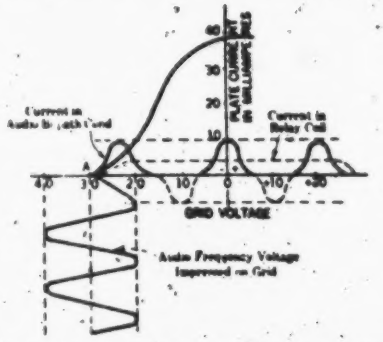

Fig. 2—Tube Characteristic Showing Principle of Operation of Relay Recorder

Fig. 1 shows the wiring diagram. *A* is a telephone plug for connecting the relay device to the amplifier output. *B* is a phone socket, so that if desired the operator may listen to the received-signal in the ordinary way. *C* is an audio transformer of the type used in audio amplifiers, the type used at present being a Signal Corps Type C-21. *E* is a two-megohm, grid leak.

To be presented at the Spring Convention of the A. I. E. E., Chicago, Ill., April 19-21, 1922.

PLAIRTIFFS' EXHIBIT No. 53, Sheet 2
(A.I.E.E.Journal, April 1922, Page 2)

Q is a 0.0006-microfarad variable condenser or 0.0003-microfarad fixed condenser. D is a 60-volt variable "C" battery variable in steps of approximately three volts. J is a 160-volt dry "B" battery self-contained within the set. K is a type UV-201 Radiotron. F and H are each a one-microfarad paper condenser. T is an ordinary telegraph relay rewound with 12,000 turns of number 38 S. S. C. enamel wire. A' is the output to be connected to the apparatus to be controlled. L is a step-down transformer for operating the tube filaments from the 110-volt a-c. supply when such a supply is available.

4. *Principle of Operation.* The principle of operation is illustrated in Fig. 2. By means of the variable "C" battery D, the grid voltage is adjusted to approximately 30 volts at which value the plate current is zero, as shown at A. The incoming audio-frequency voltage impressed on the grid varies the grid potential,

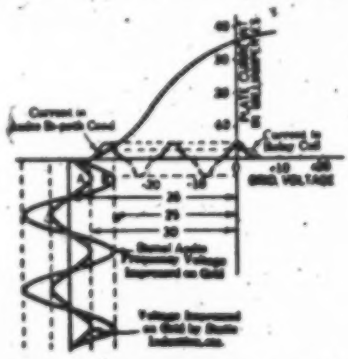

FIG. 3—METHOD OF ELIMINATING STATIC AND INDUCTION NOISES WHICH ARE NOT STRONGER THAN THE SIGNAL

for example, from − 30 to − 20 volts. The 10 volts decrease from − 30 to − 20 causes an increase, for example, from 0 to 10 milliamperes, while the increase from − 30 to − 40 volts is not effective in causing a plate current to flow due to the fact that − 30 volts is already sufficient to reduce the plate current to zero. The result will be a pulsating direct current of 10 milliamperes, maximum amplitude, in the plate circuit. This urrent, flowing through the plate circuit and condenser F causes an increase in the plate current at the keying frequency, which change, passing through the relay coil will pull the relay armature over, making contact at T, which contact may control any mechaniam desired. With the "C" battery grid voltage adjusted for maximum sensitivity it was found that static induction, etc., operated the relay. When these disturbances are not as strong as the signal their effect on the relay may be overcome as shown in Fig. 3. For example, the "C" battery is shown increased to − 35 volts, the critical value for maximum sensitivity being − 30 volts. The disturbances due to stray currents, etc., merely reduce the "C" battery voltage to − 30 which is not sufficient to cause plate current to flow. However, the signal, being of greater intensity than the stray currents, reduces the voltage to − 25 which causes a plate current of five milliamperes. It will be seen therefore that all disturbing effects, if of less intensity than the signal, do not affect the relay.

5. *Method of Increasing Sensitivity and Selectivity.* During the development of this relay it was found that the rectified audio-frequency current in the plate circuit caused the relay armature to chatter rapidly and make a poor contact with the fixed contact point through which the circuit is closed. This was overcome completely, however, by the addition of a one-microfarad condenser across the relay coils. This served the purpose of an audio-frequency by-path for the highly inductive winding of the relay, thus greatly decreasing the resistance of the circuit. The change of plate current due to this audio-frequency caused a second change which occurred at the keying frequency. This latter change passes readily through the relay coils and exerts a strong steady pull on the relay armature without the least chattering.

It was also found that the 0.0006-microfarad variable condenser, Fig. 1, across the secondary of the input audio transformer made possible audio tuning, which increased the selectivity considerable. This tuning was very sharp and it was found that European stations could be made to operate the relay while a high-power station here in the United States would fail to operate it, although the high-power station was coming in on the same wave length and slightly stronger. This was made possible by adjusting the heterodyne note of the European station to a frequency different from that of the local station and then tuning the secondary of the audio transformer to that frequency. The 0.0006-microfarad variable condenser may be replaced by a 0.0003-microfarad fixed condenser and the audio tuning accomplished by adjusting the heterodyne note to the resonant frequency. By means of this audio tuning one of three stations transmitting simultaneously has been selected and caused to operate the relay although all were of equal intensity.

By the use of two relay recorders connected in series across the output terminals of a single radio receiving set, two messages sent on practically the same wave length, but of different audio frequencies, have been accurately received simultaneously.

6. *Speed of Operation.* Tests showed that with a signal strength sufficient to produce a plate current of 10 milliamperes the relay could be operated at a speed of 48 contacts per second, the contact being sufficient to operate a buzzer. With three milliamperes in the plate circuit a speed of 27 contacts per second was obtained. With one milliampere a speed of 19 per second. In each case the relay armature spring tension was adjusted for the best operation.

7. *Sensitivity.* As stated above, this relay was designed primarily with the intention of obtaining a device which should be durable, simple in operation, and strong in construction. Sensitivity is obtained by

means of radio-audio amplification thereby increasing the voltage input to the relay circuit and eliminating the necessity of extreme sensitivity in the relay. Tests at 600 cycles showed that the relay circuit was fairly sensitive, as approximately 1.3 volts at the input terminals of the audio transformer in the relay circuit, caused a current of five milliamperes to flow through the relay coil in the plate circuit.

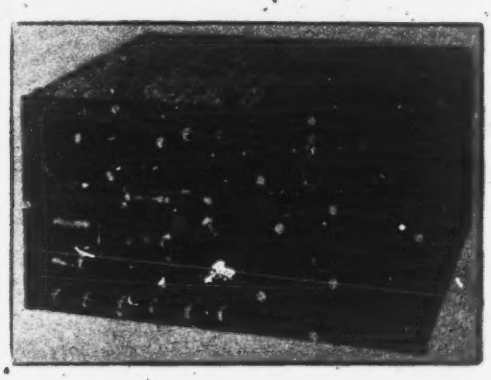

FIG. 4.—TYPE A RELAY RECORDER FOR USE WITH BATTERIES

8. *Durability.* As the relay instrument used in this recorder is of the ordinary telegraph type its durability is well established. The only elements requiring occasional renewal are the two electron tubes, the 60-volt "C" battery, and the 160-volt "B" battery.

9. *Portability.* The complete recorder with the exception of the filament lighting battery is contained in a cabinet 7 in. by 13 in. by 11 in., as shown in Fig. 4.

10. *Uses.* 1. As an ordinary receiver it has advantages over reception with telephone receivers, for one may receive by buzzer or sounder with all induction and interfering noises eliminated (if not louder than the signal.)

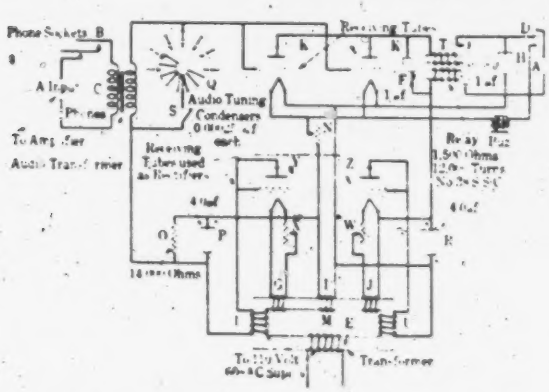

FIG. 5.—CIRCUIT DIAGRAM OF RELAY RECORDER FOR USE ON THE 110-VOLT A-C. SUPPLY

2. A tape or drum-type recorder may be used and a copy made without a trained radio operator.

3. Time signals may be recorded.

4. A call system may be worked by a time switch connected to close the filament circuit for a given time at set calling intervals.

5. Any form of mechanism may be operated by an incoming signal.

6. A receiving station may be located remotely from the transmitting station and the radio signals relayed by wire to the operating room some miles distant.

In conclusion it may be stated that a relay of this type should operate satisfactorily, *without attention*, on an airplane where mechanical vibration may be excessive as the pull on the armature with three milliamperes, or over, in the relay coil makes possible the use of a spring tension on the relay armature sufficient to keep it from moving due to mechanical vibration of the relay.

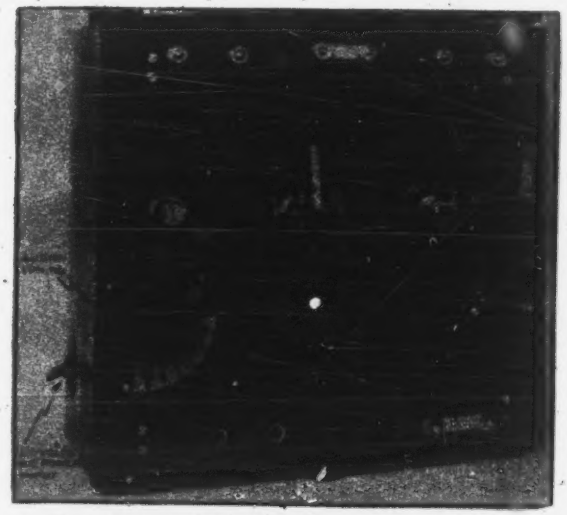

FIG. 6.—TYPE B RELAY RECORDER FOR USE ON THE 110-VOLT A-C. SUPPLY

It would seem that the above-mentioned feature makes this remote control relay more serviceable than those now on the market which require delicate adjustment of spring tension, contact points, and suspended vibrating elements.

TYPE B.—FOR USE ON THE 60-CYCLE, 110-VOLT, A-C. SUPPLY

This recorder is similar in construction and operation to the Type *A* recorder, except that the plate and grid voltages (B and C battery) are supplied from the 60-cycle, 110-volt a-c. supply. The current for operating the tube filaments is also obtained from this source, so that the recorder is operated entirely independent of any form of batteries. It is only necessary, therefore, to connect to the 110-volt a-c. line and the recorder is ready to operate.

The method of operating the recorder from the a-c. supply consists in the use of the two receiving tubes as rectifiers as shown in Fig. 5. The tubes *Y* and *Z* are used as half wave rectifiers, one supplying the plate voltage, and the other the grid voltage. When used

PLAINTIFFS' EXHIBIT No. 53, Sheet4
(A.I.E.E.Journal April 1922, Page 4.

as rectifiers, receiving tubes should have the grids and plates electrically connected together. A special transformer M with six windings is used. Two of the windings G and J, supply the filaments of the two rectifier tubes. A third, I, the filaments of the recorder tubes. A fourth, U, the high voltage for the plate. The fifth, L, supplies the grid voltage, and the sixth, E, is the 110-volt primary winding. The rectified alternating current is smoothed out by means of four microfarad condensers P and R, connected across the output terminals. As the currents in the grid and plate circuits are small, smoothing out inductance was found unnecessary. It was found necessary to put 40,000 ohms as shown at O, across the output circuit of the rectifier tube supplying the voltage to the grid, as the grid is otherwise insulated from the filament of tubes K by the rectifier tube. By means of the filament rheostats, X and W, the grid and plate voltages may be varied over any ranges desirable for the most efficient operation of the recorder. By the use of binding posts with straps as shown in Fig. 6, the type B recorder may be operated from A, B and C batteries for supplying the filament, plate and grid voltages respectively in cases where the a-c. supply is not available.

In cases where very high-speed operation is desired, the ordinary relay may be replaced by one designed for high-speed operation.

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Radio News for July, 1922 (Radio News July, 1922, Page 51) 51

A Relay Recorder for Remote Control by Radio

By F. W. DUNMORE*

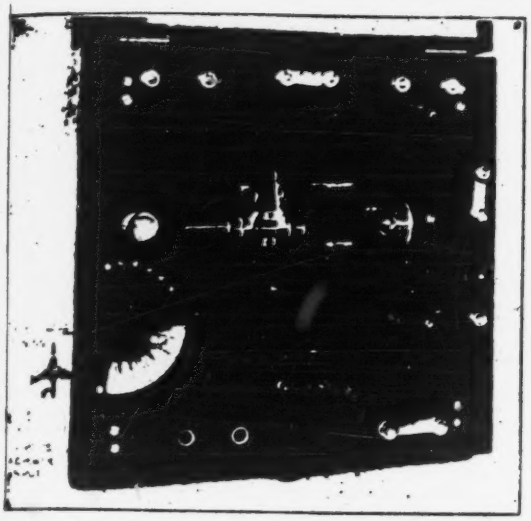

Fig. 6. Type B Relay Recorder for Use on the 110-Volt A. C. Supply

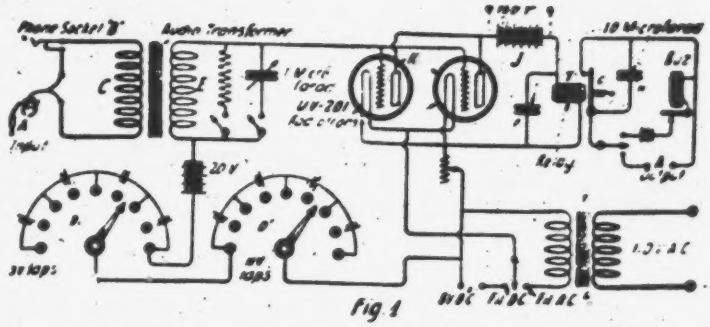

Fig. 1. Circuit Diagram of the Relay Recorder for Use with a D. C. Source

TYPE A—FOR USE WITH BATTERIES

1. *Object of Development.*—The object of this investigation was to develop a relay which should operate by received radio signals.

2. *Requirements.* To be satisfactory as a relay recorder the device should have the following characteristics: (1) it must be of simple construction with few adjustments; (2) it must be easy to adjust and capable of being put into operation quickly; (3) it must be selective and as free from static and such disturbances as possible; (4) it must be capable of operating at a speed of at least 12 times per second; (5) it must respond to weak signals; (6) it must be of strong design, durable and capable of maintaining its adjustments; (7) it must be portable.

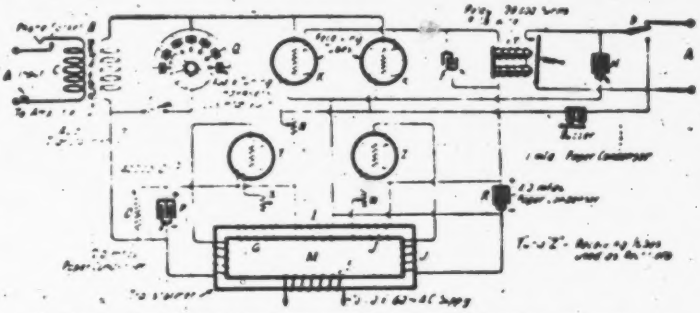

Fig. 8. Hook-up of Relay Recorder for Use On the 110-Volt A. C. Supply

3. *Circuit Used.* In order to avoid the use of a very sensitive relay designed to operate on currents of a milliampere or less, with delicate adjustments and light contacts and spring tension, advantage was taken of the radio-audio amplifier (which has now become a reliable radio instrument) to increase the input voltage to the relay circuit, thus making possible the use of a simple ordinary, high-resistance telegraph relay. The relay device has therefore been developed to operate from the output circuit of any suitable amplifier in place of the ordinary telephone receivers.

The only adjustment necessary is that of an ordinary telegraph relay.

Fig. 1 shows the wiring diagram. *A* is a telephone plug for connecting the relay device to the amplifier output. *B* is a phone socket, so that if desired the operator may listen to the received signal in the ordinary way. *C* is an audio transformer of the type used in audio amplifiers, the type used at present being a Signal Corps Type C-21. *E* is a two-megohm, grid leak. *Q* is a 0.0006-microfarad variable condenser or 0.0003-microfarad fixed condenser. *D* is a 60-volt variable "C" battery variable in steps of approximately three volts. *J* is a 160-volt dry "B" battery self-contained within the set. *K* is a type *UV*-201 Radiotron. *F* and *H* are each a one-microfarad paper condenser. *T* is an ordinary telegraph relay rewound with 12,000 turns of number 38 S. S. C. enamel wire. *A'* is the output to be connected to the apparatus to be controlled. *L* is a step-down transformer for operating the tube filaments from the 110-volt a-c. supply when such a supply is available.

4. *Principle of Operation.* The principle of operation is illustrated in Fig. 2. By means of the variable "C" battery *D*, the grid voltage is adjusted to approximately 30 volts at which value the plate current is zero, as shown at *A*. The incoming audio-frequency 0 to 10 milliamperes, while the increase from −30 to −40 volts is not effective in causing a plate current to flow due to the fact that −30 volts is already sufficient to reduce the plate current to zero. The result will be a pulsating direct current of 10 milliamperes, maximum amplitude, in the plate circuit. This current, flowing through the plate circuit and condenser *F* causes an increase in the plate current at the keying frequency, which change, passing through the relay coil, will pull the relay armature over, making contact at *T*, which contact may control any mechanism desired. With the "C" battery grid voltage adjusted for maximum sensitivity it was found that static induction, etc., operated the relay. When these disturbances are not as strong as the signal their effect on the relay may be overcome as shown in Fig. 3. For example, the "C" battery is shown increased to −35 volts, the critical value for maximum sensitivity being −30 volts. The disturbances due to stray currents, etc., merely reduce the "C" battery voltage to −30, which is not sufficient to cause plate current to flow. However, the signal, being of greater intensity than the stray currents, reduces the voltage to −25, which causes a plate current of five milliamperes. It will be seen therefore that all disturbing effects, if of less intensity than the signal, do not affect the relay.

5. *Method of Increasing Sensitivity and Selectivity.* During the development of this relay it was found that the rectified audio-

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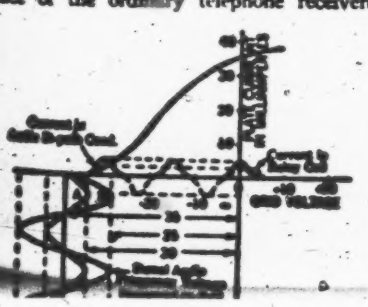
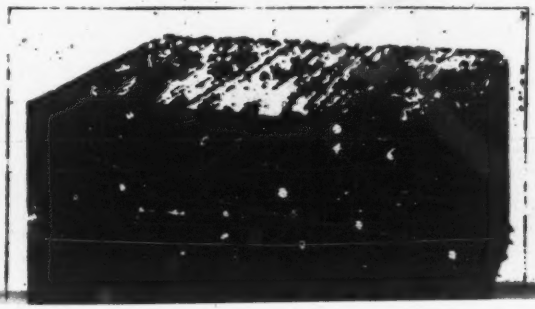




A Relay Recorder for Remote Control by Radio

By F. W. DUNMORE*

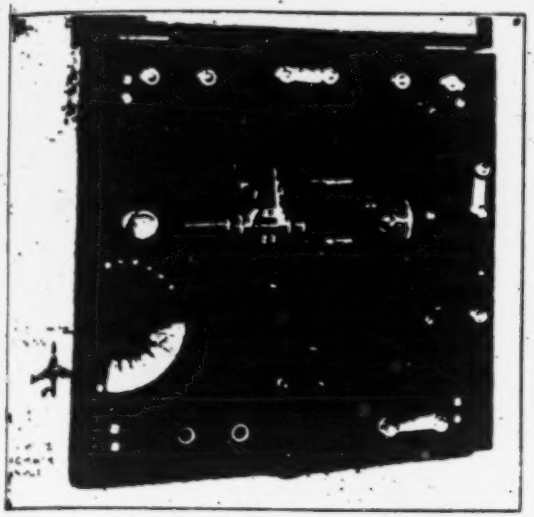
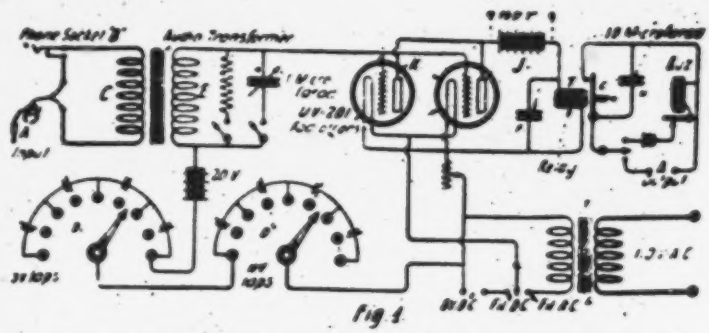


Fig. 6. Type B Relay Recorder for Use on the 110-Volt A. C. Supply



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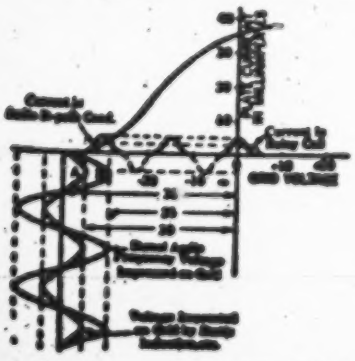

Fig. 2. Method of Eliminating Static and Inductive Effects, Which are Not Stronger Than the Signal

*Radio Laboratory, Bureau of Standards

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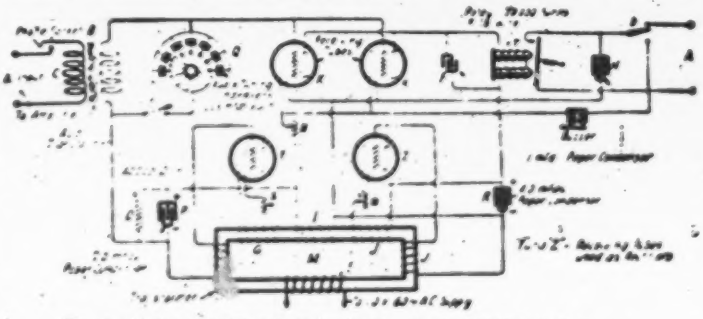

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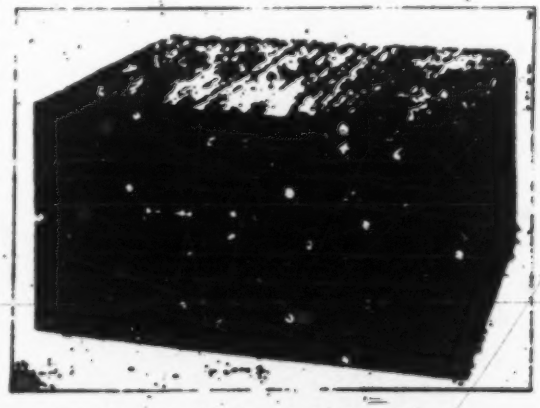

Fig. 4. Type A Relay Recorder for Use with Batteries

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Sanitary, beautiful in appearance, light in weight, cool in summer. Dirt can be wiped off with a damp cloth. If the young men in the house do not appreciate the artistic appearance of these ivory ear-caps, they—at least—should be used for the benefit of the ladies.

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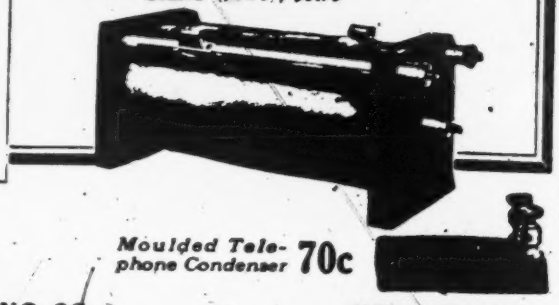
The Radisco H & M Two-Slide Tuner will tune up to practically all the broadcasting wave-lengths. Moulded ends and first-class construction throughout.

Price $4.00. With Puratone Detector Stand ($2.75), $6.75



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came more clearly than the average male voice. Records of soprano singers were unusually clear and distinct.

The value of the entire outfit is estimated at $700.

Portraits Radiated Through the Ether

(*Continued from page 23*)

board, will record a minute square of corresponding shade, thus reconstituting, element by element, the original picture.

About one thousand words are required for a portrait; a special code, however, enables this to be reduced to three hundred words. From a wireless station, a given photograph can simultaneously be sent to any number of other radio stations (also to ships on the high sea), if these, in addition to an ordinary radio receiver set, comprise a typewriter such as above described.

This method will find useful applications in the illustrated press, in banking and other lines of commercial activity, for the broadcasting of meteorological bulletins, for advertising and, alas, for military purposes as well. One of the most important uses, however, will be for the purposes of the criminal police, portraits of criminals being, in a minimum of time, circulated broadcast in all directions and to any distance, and being even received on board ship

A Relay Recorder for Remote Control by Radio

Continued from page 51

frequency current in the plate circuit caused the relay armature to chatter rapidly and make poor contact with the fixed contact point through which the circuit is closed. This was overcome completely, however, by the addition of a one-microfarad condenser across the relay coils. This served the purpose of an audio-frequency by-pass for the highly inductive winding of the relay, thus greatly decreasing the resistance of the circuit. The change of plate current due to this audio-frequency caused a second change which occurred at the keying frequency. This latter change passes readily through the relay coils and exerts a strong, steady pull on the relay armature without chattering.

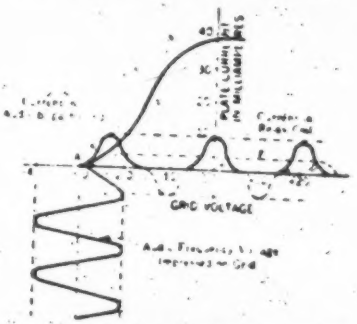

Fig. 8—Tube Characteristic Showing Principle of Operation of Relay Recorder.

It was also found that the 0.0006-microfarad variable condenser, Fig. 4, across the secondary of the input audio transformer made possible clear tuning, which increased the selectivity considerably. This tuning was very sharp and it was found that European stations could be made to operate the relay while a high-power station here in the United States would fail to operate it, although the high-

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A Relay Recorder for Remote Control by Radio

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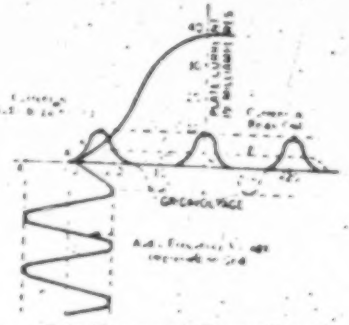

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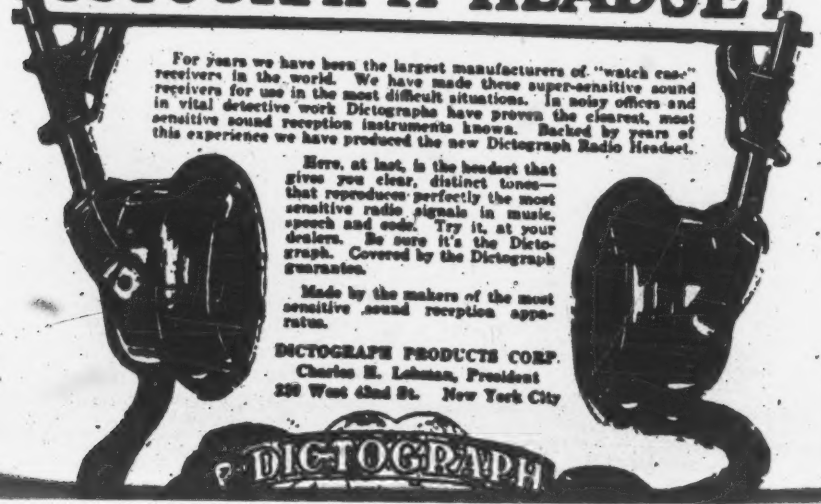

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Here, at last, is the headset that gives you clear, distinct tones—that reproduces perfectly the most sensitive radio signals in music, speech and code. Try it, at your dealers. Be sure it's the Dictograph. Covered by the Dictograph guarantee.

Made by the makers of the most sensitive sound reception apparatus.

DICTOGRAPH PRODUCTS CORP.
Charles E. Lehman, President
220 West 42nd St. New York City

former to that frequency. The 0.0006-microfarad variable condenser may be replaced by a 0.0003-microfarad fixed condenser and the audio tuning accomplished by adjusting the heterodyne note to the resonant frequency. By means of this audio tuning one of three stations transmitting simultaneously has been selected and caused to operate the relay, although all were of equal intensity.

By the use of two relay recorders connected in series across the output terminals of a single radio receiving set, two messages sent on practically the same wave-length, but of different audio frequencies, have been accurately received simultaneously.

6. *Speed of Operation.* Tests showed that with a signal strength sufficient to produce a plate current of 10 milliamperes the relay could be operated at a speed of 48 contacts per second, the contact being sufficient to operate a buzzer. With three milliamperes in the plate circuit a speed of 27 contacts per second was obtained. With one milliampere a speed of 19 per second. In each case the relay armature spring tension was adjusted for the best operation.

7. *Sensitivity.* As stated above, this relay was designed primarily with the intention of obtaining a device which should be durable, simple in operation, and strong in construction. Sensitivity is obtained by means of radio-audio amplification thereby increasing the voltage input to the relay circuit and eliminating the necessity of extreme sensitivity in the relay. Tests at 600 cycles showed that the relay circuit was fairly sensitive, as approximately 1.3 volts at the input terminals of the audio transformer in the relay circuit caused a current of five milliamperes to flow through the relay coil in the plate circuit.

8. *Durability.* As the relay instrument used in this recorder is of the ordinary telegraph type its durability is well established. The only elements requiring occasional renewal are the two electron tubes, the 60-volt "C" battery, and the 160-volt "B" battery.

9. *Portability.* The complete recorder with the exception of the filament lighting battery is contained in a cabinet 7" by 13" by 11", as shown in Fig. 4.

10. *Uses.* 1. As an ordinary receiver it has advantages over reception with telephone receivers, for one may receive by buzzer or sounder with all induction and interfering noises eliminated (if not louder than the signal).

2. A tape or drum-type recorder may be used and a copy made without a trained radio operator.

3. Time signals may be recorded.

4. A call system may be worked by a time switch connected to close the filament circuit for a given time at set calling intervals.

5. Any form of mechanism may be operated by an incoming signal.

6. A receiving station may be located remotely from the transmitting station and the radio signals relayed by wire to the operating room some miles distant.

In conclusion it may be stated that a relay of this type should operate satisfactorily, *without attention*, on an airplane where mechanical vibration may be excessive as the pull on the armature with three milliamperes, or over, in the relay coil makes possible the use of a spring tension on the relay armature sufficient to keep it from moving due to mechanical vibration of the relay.

It would seem that the above-mentioned feature makes this remote control relay more serviceable than those now on the market which require delicate adjustment of spring tension, contact points, and suspended vibrating elements.

TYPE B—FOR USE ON THE 60-CYCLE 110-

EVERYTHING Radio

Our experience as representatives of all the popular makes of radio apparatus enables us to render the best service.

We are authorized Radio Corporation jobbers, including the famous Westinghouse Receivers and new General Electric Receivers.

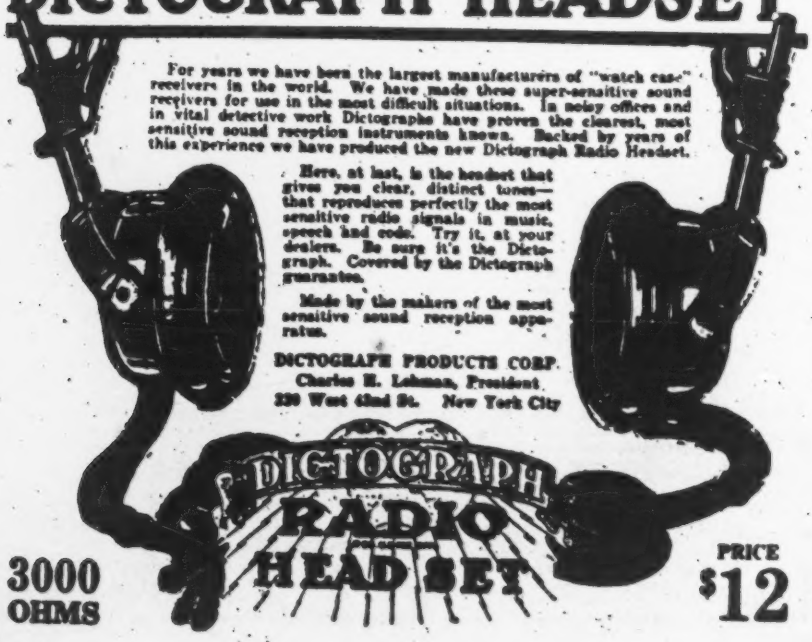
Trade Mark Registered

PHILADELPHIA WIRELESS SALES CORPORATION

1533 Pine Street Philadelphia, Pa.

Be Sure You Get the Best — Ask for the New

DICTOGRAPH HEADSET



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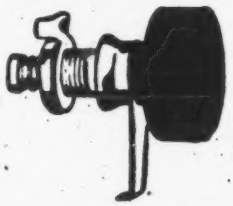
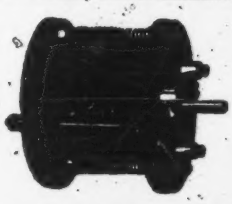
Type B—For Use on the 60-Cycle, 110-Volt, A-C. Supply

This recorder is similar in construction and operation to the Type *A* recorder, except that the plate and grid voltages (B and C battery) are supplied from the 60-cycle, 110-volt a-c. supply. The current for operating the tube filaments is also obtained from this source,



I-C

THE MARK OF QUALITY



I. C. ROTARY LEVER SWITCH

Exceptionally well designed and constructed; substantial throughout. Switch is secured to panel by means of holding nut at back. Large flange presents ample surface against panel. Terminal is held securely under bearing. Cannot turn when switch lever is operated. Bearing is threaded on outside and extends through panel. Switch designed to clear spring and spring lock. Not necessary to disassemble switch when mounted.

Adjustable spring at end of shaft insures uniform tension at all times. Operating knob is 1⅛ inches in diameter. Nickel plated; beautifully finished. Packed in individual boxes. Drilling template for contacts of 1 inch, also 1½ inch radius accompanies each switch.

Price, R-10 Radius 1".....$0.75
Price, R-12 Radius 1½".... .75

Announcement

Owing to the fact that the Industrial Controller Co. has had an unusually wide experience in the manufacture of apparatus for radio equipment; also the fact that their manufacturing facilities are particularly suited to specializing on certain parts of radio equipment, this company is placing on the market a quality line of condensers, switch parts, and other apparatus as used in amateurs' small receiving sets.

These devices are featured by the same quality and high-grade workmanship which has always characterized I. C. products; yet they are offered at a fair price.

For a number of years, the U. S. Government, also many of the large radio companies, have used, in connection with radio equipment, apparatus built by the Industrial Controller Company.

In purchasing I. C. equipment, you are assured substantial construction, practical design and satisfactory results.

I. C. VARIABLE CONDENSER

Substantial construction in every detail. Movable plates carried on a large hexagon shaft; separated by accurately machined spacers. Holes in plate are hexagon, and fit closely to the shaft, insuring correct alignment of the plates.

Bearings are large. An adjustable thrust bearing is provided. Sliding contact is provided for movable plates. Current is not carried through the bearings.

Tension spring is easily adjustable so that tension may be changed to suit the operator.

The condenser is arranged for panel mounting, although with a very slight change it may be used for table mounting.

All parts are nickel plated.

The condenser is made in the following sizes:

R-50—11 plates, capacity .00025 MFD..... $4.25
R-55—23 plates, capacity .0005 MFD..... 4.50
R-60—43 plates, capacity .001 MFD..... 4.75

See Your Dealer

Industrial Controller Co. MILWAUKEE WISCONSIN

so that the recorder is operated entirely independent of any form of batteries. It is only necessary, therefore, to connect to the 110-volt a-c. line and the recorder is ready to operate.

The method of operating the recorder from the a-c. supply consists in the use of the two receiving tubes as rectifiers as shown in Fig. 5. The tubes *Y* and *Z* are used as half wave rectifiers, one supplying the plate voltage, and the other the grid voltage. When used as rectifiers, receiving tubes should have the grids and plates electrically connected together. A special transformer *M* with six windings is used. Two of the windings *G* and *J* supply the filaments of the two rectifier tubes. A third, *I*, the filaments of the recorder tubes. A fourth, *U*, the high voltage for the plate. The fifth, *L*, supplies the grid voltage, and he sixth, *E*, is the 110-volt primary winding. The rectified alternating current is smoothed out by means of four microfarad condensers *P* and *R*, connected across the output terminals. As the currents in the grid and plate circuits are small, smoothing out inductance was found unnecessary. It was found necessary to put 40,000 ohms as shown at *O*, across the output circuit of the rectifier tube supplying the voltage to the grid, as the grid is otherwise insulated from the filament of tubes *K* by the rectifier tube. By means of the filament rheostats, *X* and *W*, the grid and plate voltages may be varied over any ranges desirable for the most efficient operation of the recorder. By the use of binding posts with straps as shown in Fig. 6, the type *B* recorder may be operated from *A*, *B* and *C* batteries for supplying the filament, plate and grid voltages respectively in cases where the a-c. supply is not available.

In cases where very high-speed operation is desired, the ordinary relay may be replaced by one designed for high-speed operation.

Abstracted from the Journal of Institute of Electrical Engineers, April, 1922.

Universal Amplifier Invented

(Continued from page 32)

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Warns of Fire Danger

KEYSTONE RADIO ARRESTERS

Approved by Underwriters

To protect your radio apparatus and your property against lightning and to take off static accumulations. Can be installed outdoors where a lightning arrester belongs, highly efficient, no vacuum to lose, no fuse to blow, offers permanent protection. Takes the place of a lightning switch.

For sale by Radio Dealers, Department Stores and Electrical Dealers everywhere.

Electric Service Supplies Co.
Mfrs. of Lightning Arresters for 30 Years
17th & Cambria Sts., Phila.

Type A, Keystone Arrester, with wire leads. Price $2.00

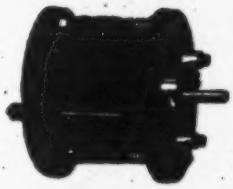
Type B, Keystone Arrester, with binding posts. Price $2.00

LATEST RADIO SENSATION

[illegible] Radio set on the market. A question to Radio. The neatest, most compact and efficient. Both

I-C

THE MARK OF QUALITY



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LATEST RADIO SENSATION

The best crystal Radio set on the market. A sensation in Radio. The neatest, most compact and efficient. Built entirely different. Must be seen to be appreciated. Retail price, $25.00. Sample sent prepaid on receipt of $12.00. Wonderful proposition to jobbers and dealers.

RADIO DIALS

Three inch polished aluminum dials without knobs. 0 to 100 scale reading. Price, $12.50 per hundred.

CLINTON RADIOPHONE CO., Dept. A, 29 S. CLINTON ST., CHICAGO, ILL.

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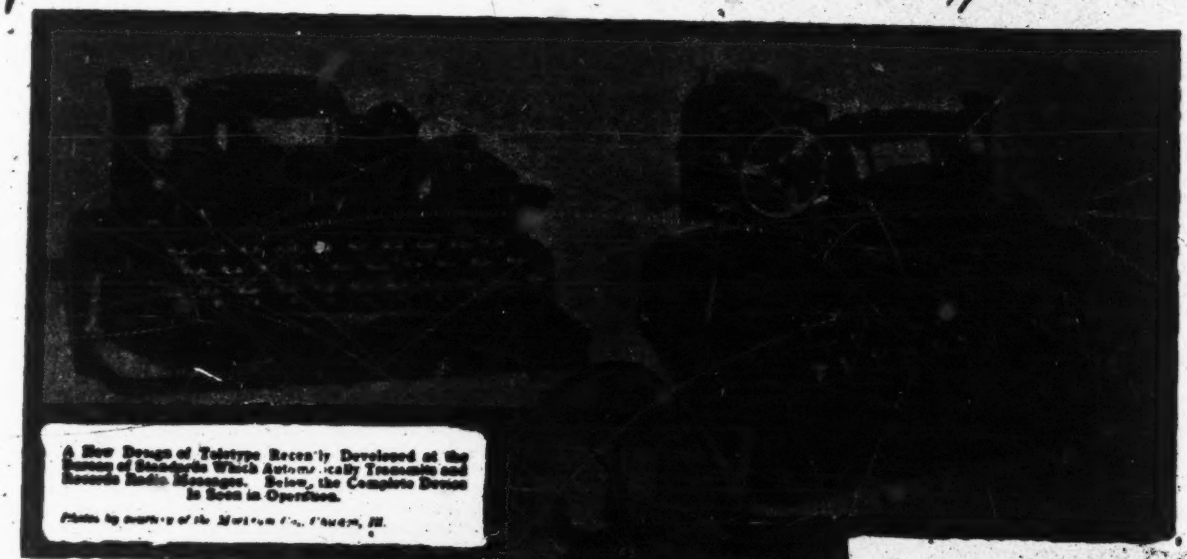
PLAINTIFFS' EXHIBIT No. 59, Sheet 1.
(Radio, Nov. 1922, Page 838)

Radio Messages Typed Automatically From Airplane to Ground

By S. R. WINTERS



A New Design of Teletype Recently Developed at the Bureau of Standards Which Automatically Transmits and Records Radio Messages. Below, the Complete Device in Use in Operation.

Photos by courtesy of the Morkrum Co., Chicago, Ill.

CHAMPION typists who now manipulate the keyboard of typewriters with incredible swiftness under the staid environments of offices may in the future qualify as speed demons when aloft in airplanes. The clack of the typewriter keys may vie for supremacy with the din of noise of the magnetos of the aircraft engine. Moreover, the rapid depression of the keys of this form of printing machine may be faithfully recorded by means of radio telegraph on a printing unit in a wireless receiving station planted on the ground. Withal, this strange adventure marks the application of the mechanism now employed in the automatic transmission and reception of telegrams by the line-wire system of communication to the sending of messages by the medium of electro-magnetic waves through space.

This radical departure, evidencing the constant and surprising developments in the application of radio-communication, is made possible by the adaptation of a modified form of the "Teletype," an instrument highly developed for telegraph stations in the transmission and reception of telegrams automatically. The electric impulse, however, in this instance, travels along a wire, and as the name might imply, the operator "tells it to the type" instead of some other vehicle of conveyance. It is almost human in its behavior, which habitual demonstration in land-line telegraphy probably occasioned the inquisitive scientific mind of John B. Brady, of Washington, D. C., to ponder its application to communicative purposes in the absence of wires—"space radio," to be explicit. Its service on board aircraft was only one of the several uses suggested, this application being given priority and prominence of mention in this article by reason of its spectacular tendency. The interchange of messages between two points on land, intercommunication between sea-faring vessels and between ships and shore, are among the potential services indicated when the "Teletype" and Hertzian waves form a unity of purpose.

The counsel and practical assistance of a formidable array of radio-engineering and mechanical talent was enlisted for the negotiation of the trail-blazing experiments, which have been conducted intermittently for a period extending over a year or more. The Morkrum Company of Chicago, inventors and manufacturers of the "Teletype," was committed to the plans of the innovation and contributed the services of J. O. Carr and Ronald S. Wishart in hopes of realizing the aims of the preteptious undertaking. The personnel and resources of the Bureau of Engineering of the United States Navy Department were pledged to the ends of achieving results, despite the skepticism expressed by one or two of the members of the radio-engineering laboratories whose concurrence was required of the success of the daring departure. Among those whose co-operation has contributed to the relative triumph of the adventure are Commander Stanford C. Hooper, head of the Radio Division of the Bureau of Engineering; Lieutenant-Commander E. H. Loftin; John B. Brady, an officer of the Naval Reserve Force; Alfred Crossley, expert radio aide; Commander A. H. Taylor, in charge of the Naval Aircraft Station at Anacostia; Dr. L. W. Austin, head of the Radio Research Laboratory of the Navy Department; Dr. John M. Miller; Lieutenant H. W. Kincheu; L. [illegible] Yorke; C. B. Mirick; and Messrs. Meyers and Judson.

The initial experiments were conducted between the Radio Research Laboratory of the Navy Department, located at the Bureau of Standards, and the Naval Aircraft Station at Anacostia—approximately eight miles intervening. The "Teletype" for these tests

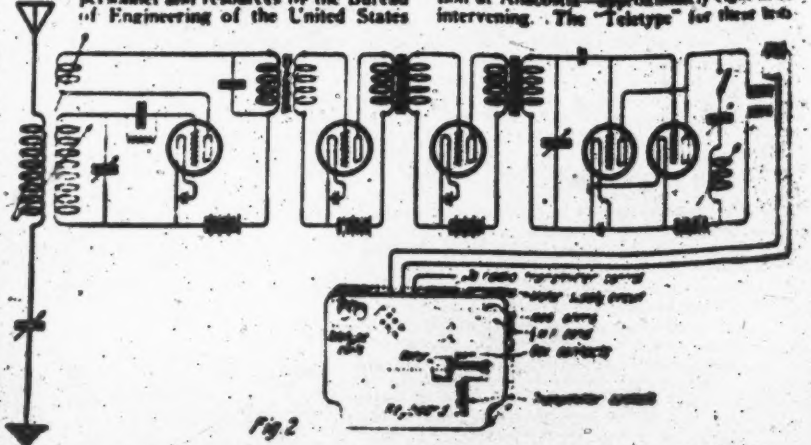
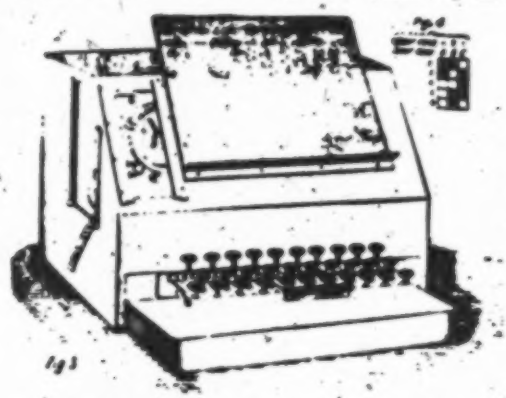
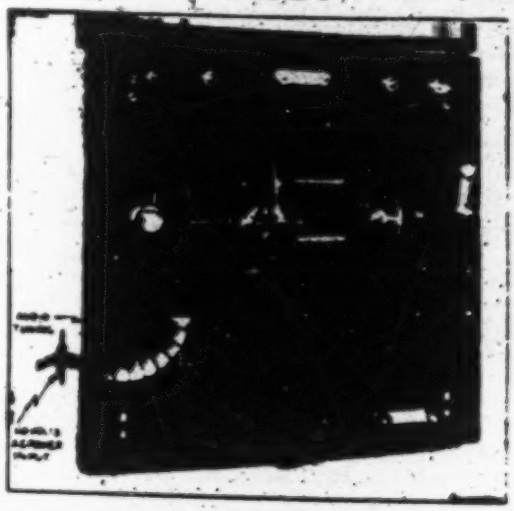


Fig. 2

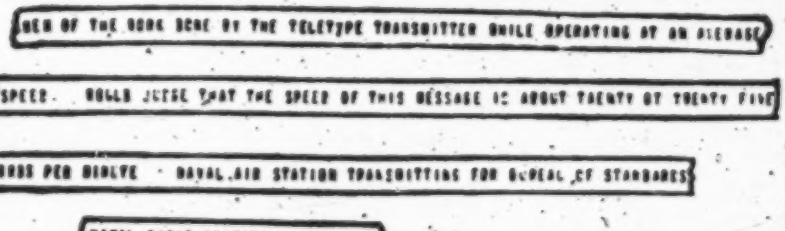
The Radio Receiving System at the Bureau of Standards With the Connections for the Teletype to Permit Automatic Reception.



The keyboard of the Teletype operator bears levers which control the opening and closing of contacts. Each letter is represented by a certain number of closings and openings. On the right is the special relay used at the receiving stations.



was loaned to the Government by J. O. Carr and Ronald S. Wishart, respectively manager and assistant manager of the Sales Engineering Department of the Morkrum Company. The ultimate objective was to transmit wireless signals by manipulation of a keyboard bearing striking similarity to that of a typewriter, through space, for a distance of several miles in such a trustworthy manner that they might be faithfully recorded automatically at the radio-receiving station. The first attempt at communication in this way resulted in the jotting down of an unintelligible jumble of representations, which resembled more closely Chinese signs than the English language. Success was not despaired of since patience never ceases to be a virtue with scientists in their explorations to unfold new truths and clothe old principles in fresh garb. A series of efforts to effect intelligible communication by the strange combination of the "Teletype" and the "ether waves" brought order out of a baffling confusion, to employ a figure of speech. A speed of 45 words a minute was attained, in the transmission and reception of communications, without errors. The specimen of message transmitted from the Bureau of Standards and received at the Naval Air Station at Anacostia, exhibited as Fig. 5 in the group of illustrations herewith reproduced, substantiates the claim advanced.



Example of the Reproduction of a Message Received Automatically on the Teletype.

The Morkrum Company loaned to the United States Navy Department a set of "Teletypes," an inventive product jointly realized by Charles L. and Howard L. Krum. Briefly, as applied to the communication system founded by Bandot, the "Teletype" is an automatic transmitting and receiving mechanism for dispatching messages over telegraph wires and setting down the signals at a distant receiving station. The apparatus comprises a base scarcely larger than that of a standard typewriter, and contains a keyboard closely resembling the office utility referred to. A set of transmitting contacts are mounted on a unit driven by an electric motor whose source of supply may be either 110 volts of direct or alternating current.

The design of "Teletype" employed on aircraft derived its electric power from a 6-volt storage battery, the unit of power commonly used in radio-telephone receiving outfits for lighting the filament of the electron tube, or "King Electron," as one radio engineer is wont to dignify the importance of this electric unit. The base of this automatic device likewise supports a discriminating or selective printing mechanism, operated by the same motor previously referred to and controlled by a pair of armature coils. The latter are actuated by incoming wireless signals as a means of setting in motion the selective mechanism by which the radio signals are recorded in printed form. One complete "Teletype" was assigned for service at the Radio Research Laboratory of the Navy Department, located at the Bureau of Standards, while another set was sent to the Naval Air Station at Anacostia.

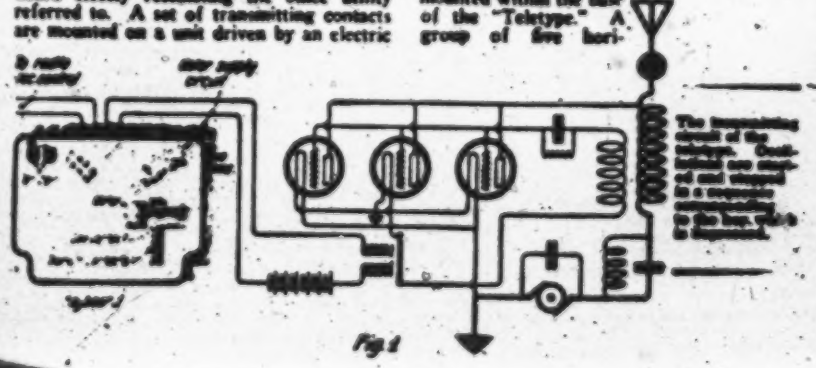
The "Teletype" was connected to the radio-transmitting apparatus, as illustrated in Fig. 1. When the keys on the keyboard of the former instrument were depressed, the effect produced was that of modulating the electron tube of the wireless transmitter, causing the going forth of impulses of energy from the radio-communication system. The keyboard, shown in Fig. 3 of the group of diagrams, is provided with a standard set of key-levers pivotally mounted within the base of the "Teletype." A group of five horizontal selector bars is arranged within the latter automatic printing device, equipped with cam facets in such a fashion that the depression of a particular key results in the cam engagement with individual bars, pushing them laterally to control the position of locking latches. These, in turn, hook over a set of goose-neck levers, picturesquely described. The levers control the opening and closing of contacts, and are, in turn, manipulated by a group of differentially positioned cams, which are continuously rotated by the motor on the "Teletype." By pressing a particular key certain of the goose-neck levers release their contacts whereby the cams in their rotation cause the closing of the radio-transmitting circuit in a sequence of impulses.

The wireless transmitting circuit may be completed through the grid circuits of the electron-tubes, as described in Fig. 1. Oscillations may be started and stopped, as well as impulses of electric energy released from the antenna, in a sequence corresponding to the particular key depressed. Differing radically from other systems of communication is the innovation of employing an impulse code possessing five units to each character. This mode of transmission is obviously at variance with the dot and dash code, commonly employed by telegraphers. For instance, the letter "a," shown in Fig. 4, may be represented by two circuit closings and three spaces, governed by the releasing of the goose-neck levers on the "Teletype."

When flung into space, consigned to the increasing burdens of the electro-magnetic waves, these impulses of electric energy may be "picked up" at receiving points and automatically printed by a receiving "Teletype." A peculiar virtue by reason of the novel combination of the latter instrument with that of the "wonderful wireless waves" is the possibility of the secrecy enveloping the transmission and reception of radio communications. This desirable feature may be accomplished by providing the communicative system with several different types of wheels for use on the printer, and at the same time making provision for a supply of removable rubber caps on the keyboard to correspond with the types of wheels employed.

The radio receiving station, in operation at the Bureau of Standards, is represented in Fig. 2 of the series of schematic diagrams. Continuous-wave transmission as-

(Continued on page 1001)



The transmitting circuit of the teletype. Oscillations are started and stopped in a sequence corresponding to the key which is depressed.

Fig. 2

336

present status of radio. No photograph, only a mere sketch, is given, and no patent numbers are given.

This aspect of the boom is the most unfortunate one, but as the public becomes more and more educated to radio the effect of the charlatan will be less felt. It is entirely up to the radio periodicals to disseminate this radio education and to assist the general public in discriminating between the good and the bad. Time will, of course, eventually result in a weeding out of the fraudulent, the incompetent, and those who, . . the Hairy Ape "do not belong."

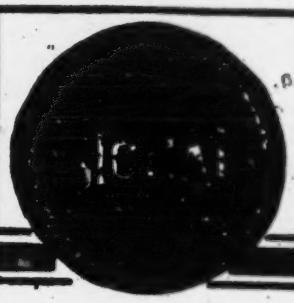
Radio Messages Typed Automatically from Aeroplane to Ground

(*Continued from page 839*)

in force and a heterodyne receiver used. Two stages of amplification were employed in the oscillating electron tube. The output of the amplifier was connected to an automatic relay recorder, shown in Fig. 6, recently perfected by F. W. Dunmore of the Radio Communication Section of the Bureau of Standards, United States Department of Commerce. This design of radio-recorder is said to be especially selective to notes of certain frequencies. The accuracy of its tuning effect is vouchsafed in the ability to transmit three different messages on the same wave-length at varying frequencies, isolating one without interference from the others.

The Dunmore relay recorder was intimately identified with the "Teletype" coils, an armature being negotiated up and down by the latter in accordance with the receipt of incoming electric impulses. The receiving printer mechanism of the "Teletype" is controlled by this armature. A clutch-and-brake device governs the starting and stopping of the printer on the receipt of wireless signals. A central shaft through the printer operates the mechanism for determining and printing the particular characters represented by the radio signals. Or, differently expressed, upon acknowledgment of electric impulses of a certain sequence the type wheel is revolved around with dispatch to print the characters represented by those wireless signals. Shifting from an explanation of the transmitting end of this communicative system to that of the behavior observed in the reception of messages the following is noted: The depression of a key on the keyboard causes the radio-active energy from the antenna in a particular sequence which is received at the receiving point, to operate the "Teletype" printer, which automatically uses discrimination and selects the character represented by the key depressed at the transmitting station and simultaneously prints that character.

Commander A. H. Taylor, in active charge of the Naval Air Station at Anacostia, suggested the possibility of the adaptation of this form of communication to aircraft as a means of exchanging intelligence with shore stations, with other units of aircraft, or between airplanes and seafaring vessels. The keyboard designed by the Markum Company for service aloft, as shown in Fig. 7 may be manipulated in the absence of knowledge of the international code; in fact, a skilled typist can operate the keyboard in an airplane with quite the facility required in fingering the office typewriter. Compactness is a virtue of the keyboard for transportation on board aircraft, it fitting snugly into the space now required for carrying the Morse telegraph key and its flame proof casing. The trailing-wire antenna common to the maintenance of radio-communication at present between different air-going machines and between wireless stations on the ground meet the requirements involved in the use of the "airplane radio typewriter."



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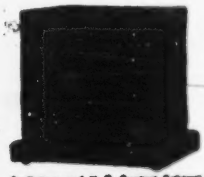

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The alliance of the "Teletype" and Hertzian waves is indicative of great possibilities in the future, if preliminary tests are to be accepted as a criterion of service. Speed in the transmission of communications to an aircraft is, of course, an outstanding virtue. Communication between ships and aircraft will be thus facilitated with the element of error minimized. Printed directions to scouting and combat airplanes may be issued by the commander-in-chief of the fleet and scouting aircraft will be enabled to convey accurate and detailed information to the commanding officers. News, market quotations, weather reports, and similar information may be faithfully copied on board passenger-carrying aircraft, as the principle of "tell it to the type" is operative as a duplex system of communication—both for the transmission and reception of wireless signals aloft.

Station 2LH at White Plains, N. Y.

(Continued from page 856)

trolling the charging outfit, which consists of a low-voltage transformer and rectifier tube.

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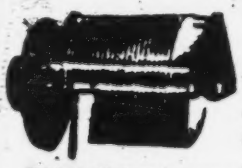

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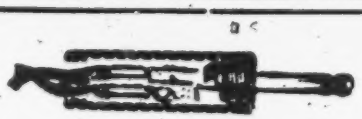

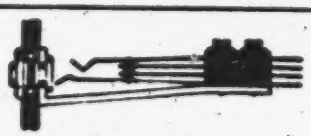

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(Page 73 of Radio Phone Receiving,
published 1922), by D. Van Nostrand
Co. N.Y.C)

that it actuates member *l*, rigidly attached to one end. This member is also anchored at its other end to the mica diaphragm *m*, which is the producer of the sounds. As the currents flow through the bobbins *bb*, the lever-diaphragm vibrates about its center point, thereby operating the mica diaphragm. This type of receiver is not only more

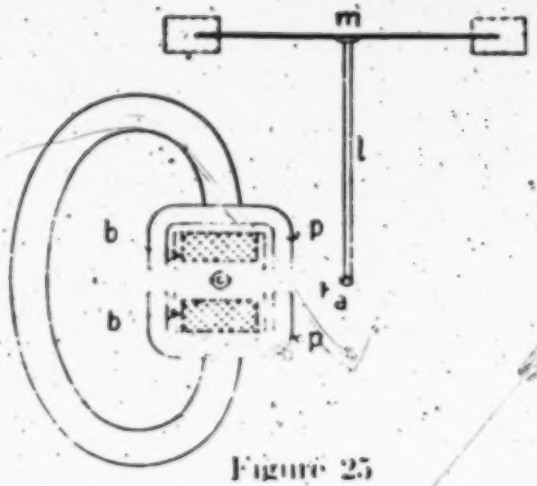


Figure 25

sensitive than the ordinary one, but also better because of the purity of the sounds produced. This is due in great measure to the lack of metallic ring in the tones emitted.

Typical Crystal Detector Set. — Figure 26 illustrates the wiring diagram of a crystal detector set which, although elaborate, will afford good tuning qualities, and respond to a wide range of wavelengths. It will be noted that the antenna circuit includes the primary coil and a short-wave variable condenser. The coil *P* consists of 60 turns of wire wound upon a cylindrical tube about 3 inches in diameter. A tap is carried out at every tenth turn, as indicated. By moving the switch, *A*, to include more turns in the circuit, the wavelength of the antenna is

increased; a decrease in the number of turns decreases the wavelength. Similarly, when the capacitance of the condenser *B* is increased, the wavelength is increased, and vice versa. By manipulating *P* and *B* simultaneously very fine tuning of the

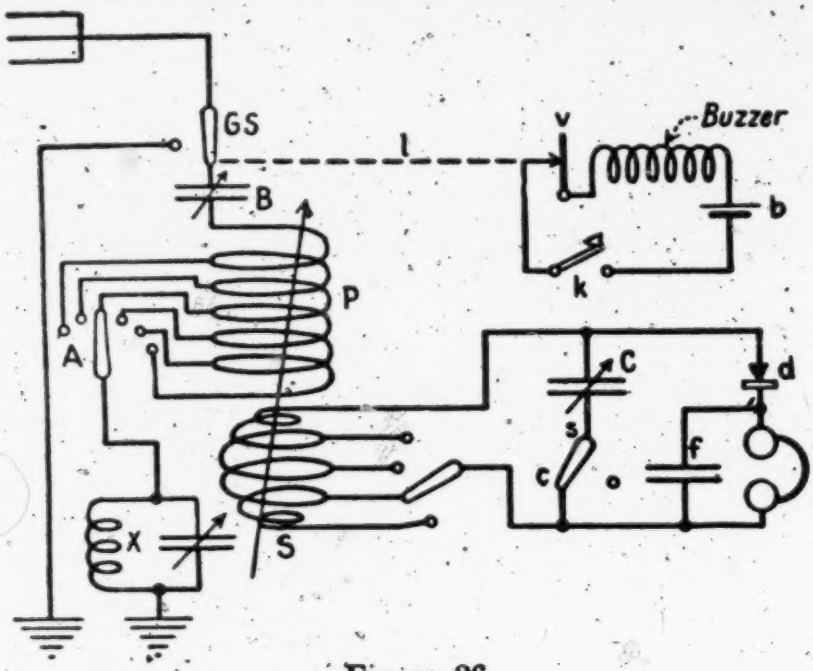


Figure 26

antenna circuit is possible. The maximum capacitance of *B* is 0.0005 microfarads.

The secondary circuit consists of another inductance *S*, also consisting of 60 turns of wire, and a variable condenser *C*. The coil *S* is wound on spherical mounting placed near one end of the cylinder supporting *P*. The coil *S* is so arranged that its axis may be shifted from coincidence with the axis of *P*, to a position displaced 90 degrees from it, thus varying the coupling from a maximum to a minimum. To facilitate tuning, the coil *S* is tapped at every 15 turns and the taps are brought out to a suitable switch. The condenser *C* is similar to condenser *B*, and may be inserted in the secondary cir-

cuit or omitted therefrom by means of switch *s*. The telephones, which should have a resistance of about 3000 ohms, are placed in circuit with the detector and the fixed blocking condenser *f*, as shown in the diagram. Condenser *f* should have a capacitance of 0.002 microfarads. The detector *d* may be either a galena or a silicon crystal.

In order to find a sensitive position on the crystal, a small buzzer is often employed. The circuit of this buzzer also is shown in Figure 26; the letters *b* and *k* signify respectively the battery and the key. A lead, *l*, is taken from one side of the vibrator V, and attached to the antenna or ground terminal of the set. With *k* closed, the surface of the crystal is explored until buzzing in the head telephones indicates a sensitive spot.

Tuning of this set is accomplished in a manner similar to the one described above. The only difference in this case is that for each setting of switch *A*, the condenser *B* is varied throughout its entire range.

The above receiving device gave excellent results when connected to a two-wire, inverted L type antenna, having a height of 20 feet and a length for the horizontal portion of 50 feet. Care must be taken not to omit the antenna grounding switch *GS*, since a good grounding switch affords protection against lightning, while a poor switch or the total absence of one introduces a lightning hazard.

Interference. — Perhaps the most annoying feature of radio telephony and telegraphy is interference by outside stations or sources. In some cases, this interference may be removed, while in others,

PLAINTIFFS' EXHIBIT NO. 61, Sheet 4. 289– 290

Plate IV. — Above: Crystal detector; *Wireless Specialty Apparatus Company*. Below: "Aeriola, Jr." crystal-detector receiving set; *Westinghouse Electric & Manufacturing Co.*

PLAINTIFF'S 291– 292

PLAINTIFFS' EXHIBIT No. 63, Sheet 1,
(Page 175 of Textbook of Radio,
published by Technical Book Co. N.Y.C.
1922)

WESTINGHOUSE CRYSTAL RECEIVING SET

The Aeriola Jr. consists of a variometer, a two-section fixed mica condenser, one telephone by-pass condenser and a crystal detector contained in a nicely finished wood box having a separate compartment for telephones, the telephones being sold with the set.

The variometer is made of micarta tubing and has a minimum amount of material in the field, thereby reducing dielectric losses. The small mica fixed condenser is connected in series with the antenna and the variometer, the small section of the condenser being used for the reception of wavelengths between 190 and 300 meters and the large section for wavelengths between 300 and 500 meters.

The crystal and telephones are shunted across a certain portion of the variometer, which gives the greatest volume of signal.

Operation

Connections from each section of the small mica condenser are brought out to separate binding posts permitting a change from one wavelength range of the set to the other by merely changing the antenna from one post to the other. With the aerial ground and telephones connected to their respective binding posts it is only necessary to adjust the crystal detector and tune with the variometer handle until the expected signal is heard. After a signal is tuned in further signal strength may be obtained by further adjustment of the detector.

PLAINTIFFS' EXHIBIT NO. 63, Sheet 2
(Page 183 of Textbook of Radio, published by Technical Book Co.N.Y.C. 1922).

293-2

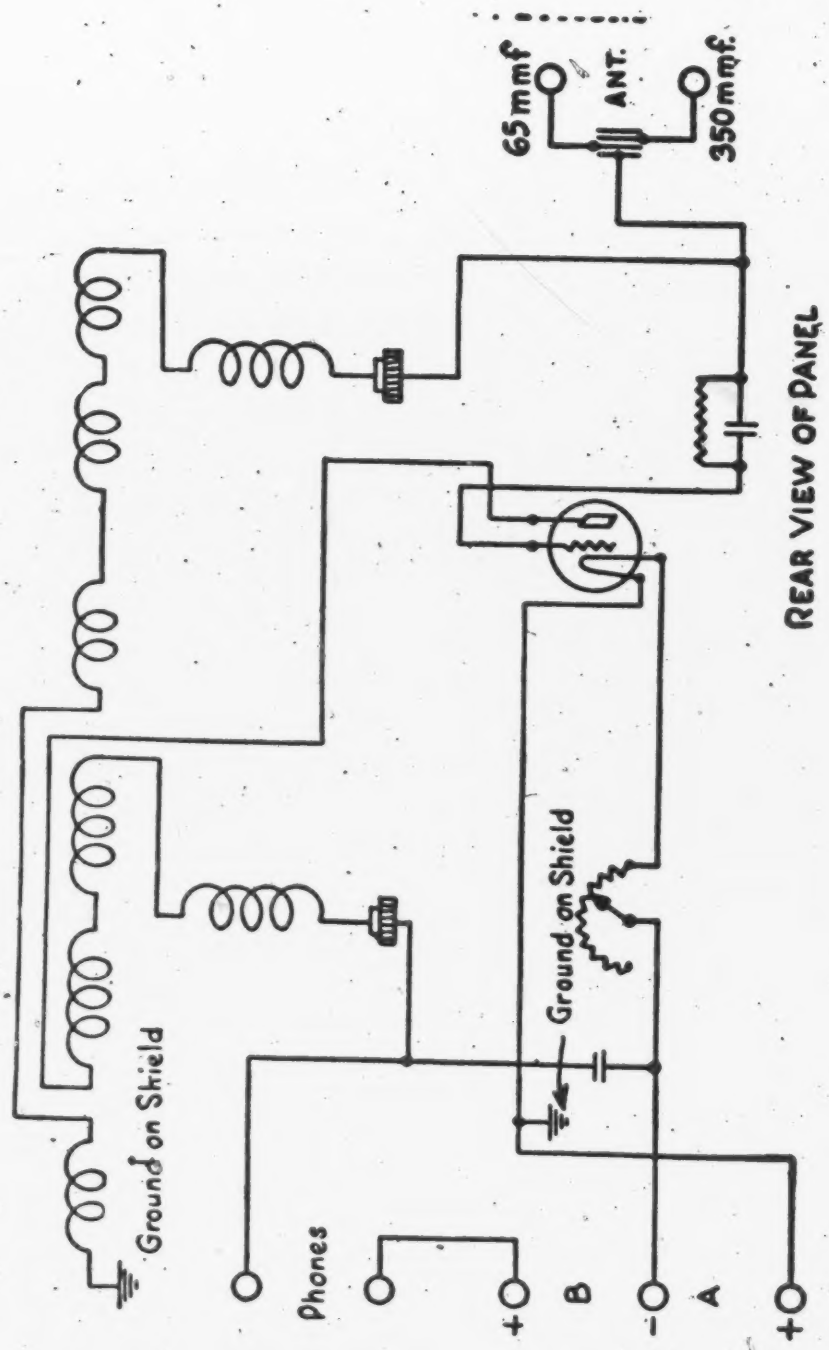


Fig. 62—Aeriola Sr. Regenerative Receiver

PLAINTIFFS' EXHIBIT No. 64, 295— 296
(Page 185, of Textbook of Radio, published by Technical Book Co.N.Y.C. 1922).

AERIOLA SR. RECEIVING SET

The Aeriola Sr., a regenerative set, was designed to satisfy the demand for a vacuum tube set which did not require a storage battery to light the filament. A special tube, developed by the Westinghouse Electric & Manufacturing Company, which requires one 1½ volt dry cell and uses .23 amperes of current to heat the filament and using either 20 or 40 volts as a plate battery, is used with this set.

Construction

The Aeriola Sr. consists of two variometers, the stator windings of each being wound on the same micarta tube, the distance between windings and the value of each stator and rotor winding being such as to give an even increase in regenerative control.

One variometer is used as a tickler winding for securing regeneration and the other variometer serves as a variable inductance which is used in conjunction with the two sections of the small mica condenser to secure the wavelength range of 190 to 500 meters.

A rheostat having the resistance wire wound on special fibre support and the resistance unit secured to a moulded porcelain base is used to control the filament current.

The bulb socket is set back from the panel so as to allow the top of the tube to protrude through a hole in the panel far enough to permit removal of the tube, yet not so far as to prevent the lid of the box being closed when the tube is in the socket.

PLAINTIFFS' EXHIBIT NO. 65,
(Page 134 of "Radio Phone Receiving, published 1922 by D. Van Nostrand Co. N.Y.C.)
297—298

amplification, and a special system of amplification that avoids some of the limitations both of audio-frequency amplification and of simple radio-frequency amplification will be described later.

Regeneration Without Oscillation for Increasing Response in Telephone. — Consider the details of regenerative reception by reference to Figure 51, which is identical with Figure 30, except for the presence of the "tickler coil." In both figures, when an oscillation is impressed by a passing wave, the current in the plate circuit will have a radio-frequency pulsation in addition to the audio-frequency pulsation that actuates the telephone receiver (see Figure 31); or, what is the equivalent

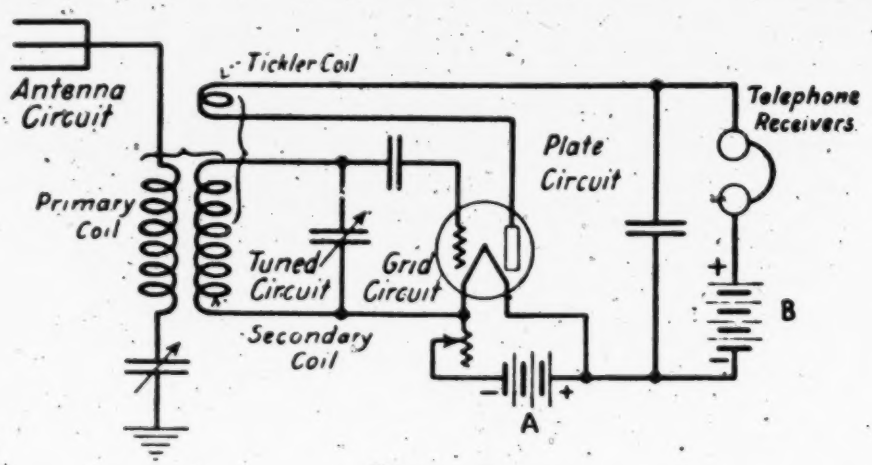


Figure 51.

there is present in the plate circuit a radio-frequency current superposed on the audio-frequency current and on the direct current. No use is made of this radio-frequency plate current in the circuits of Chapter IV; but in Figure 51 the radio-frequency plate current flows through the tickler coil and so induces a radio-frequency voltage in the secondary coil coupled therewith. If these coils have the right

PLAINTIFFS' EXHIBIT No. 66, Sheet 1, 299–300
(Page 177 of Textbook of Radio, published by Technical Book Co. N.Y.C. 1922)

WESTINGHOUSE TYPE R. C. SET

The type RC regenerative set was designed to be used for operation of a loud speaker and for long distance reception with the use of telephones.

Construction

This set consists of the type RA tuner, the type DA detector amplifier and the type CB loading coil. The wavelength range of the set is 180 to 700 meters, with the loading coil short circuited, and 1600 to 2800 meters with the loading coil in circuit. This range permits reception of amateur broadcasting, up to 700 meters, as well as commercial and time signals between 1800 and 2800 meters, with the loading coil in circuit.

The tuner consists of a variable condenser and variometer mounted on the same shaft, as a tuning unit. The capacity and inductance of the circuit is thereby increased simultaneously and in the proper L to C ratio. The tuning condenser is paralleled by a three-plate vernier condenser for sharp tuning. A tapped tickler is used on the type RC set and is wound on the same tube and alongside of the stator winding of the variometer. The tickler is so tapped as to permit close adjustment of regeneration, thereby securing maximum sensitivity.

The amplifier used in this set consists of a socket for the detector tube, telephone by-pass condenser, two sockets for amplifier tubes, two special audio frequency transformers and two moulded porcelain base

PLAINTIFFS' EXHIBIT NO. 66, Sheet 2,

301- 302

rheostats. The detector and amplifier tubes are mounted on a flexible rubber shock absorbing cradle, which prevents audio noises due to local vibrations from being amplified. Three jacks are provided so that the detector tube, first step of amplification, or second step of amplification, may be used.

The loading coil used with the set consists of two universal wound coils, one used as a loading inductance and the other as a tickler for regenerating the loading inductance. The two coils are mounted in a block moulded bakelite enclosed case which is equipped with a plunger type switch to short circuit the loading coil when using the short wavelength range of the set. The switch permits permanent installation of the loading coil on the set. The leads of the coils are brought out to the four legs of the switch blades, an extension of these blades also serves as a connection to be clamped under the binding posts of the set.

An electro-static shield is used to minimize the capacity effect of the operator's body, this shield is located on the back of the panel and is kept at ground potential.

The tickler and tuning knobs are secured to Micarta shaft extensions, thereby further minimizing capacity effect of the operator's body. The connections are brought out to the rear of the tuner and amplifier by means of extension rods, and the high potential connections are thereby kept away from the operator, avoiding the capacity effect of the body, and, detuning and howling, as consequent results.

The lead from the grid inductance is connected to the positive side of the filament of the detector tube and the transformer secondary winding is connected to the negative side of the filament of the amplifier

303–304

81

PLAINTIFFS' EXHIBIT NO. 66, Sheet 3.

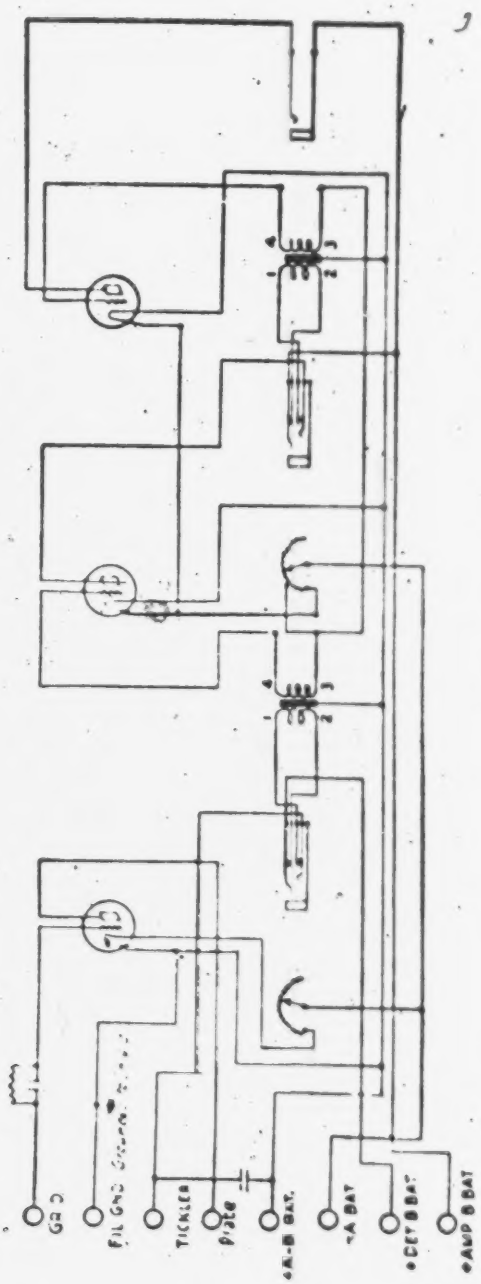


Fig. 60

Wiring Diagram of Detector and Two-Stage Amplifier

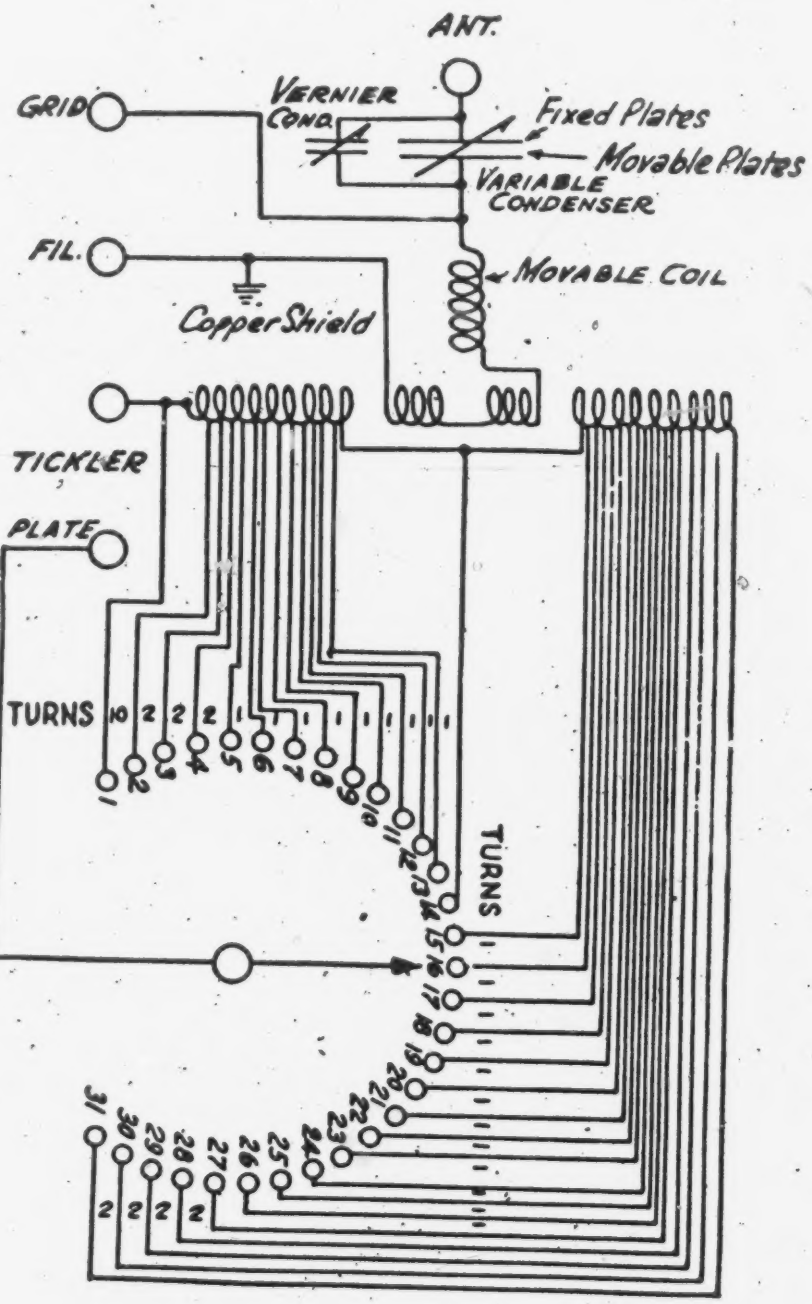


Fig. 61—Westinghouse Single Circuit Type Radio Receiver

tubes, with a bias of approximately one volt obtained by keeping a certain portion of the filament rheostat between the transformer winding and the filament of the tube. This grid bias allows a material increase in amplification, and is such as to cause the least amount of distortion in the reception of speech or music.

In connecting up the Type RC set it is necessary to put a jumper (furnished for that purpose) between the grid binding post of the tuner and the grid binding post of the amplifier, and also a jumper between the tickler binding post of the tuner and the tickler binding post of the amplifier. The loading coil is then connected between the filament post of the tuner and the filament post of the amplifier and between the plate binding post of the tuner and the plate binding post of the amplifier in such a manner as to have the loading coil switch handle vertical and at the top of the cabinet. (In the absence of a loading coil put jumpers in between the tuner and amplifier to replace the loading coil.) The aerial and "A" and "B" batteries are to be connected to their proper binding posts of the set and the ground connection taken off of the filament binding post of the amplifier. If a "soft" (low vacuum) tube is used as a detector, do not connect more than 22½ volts across the detector "B" battery binding posts.

Operation

To operate the set, plug the telephones in on the detector, first step of amplification or second step of amplification, adjust the tickler for regeneration by means of the tickler dial on the panel and tune by means of the large tuning dial on the panel until the

desired signal is heard. For a finer adjustment of tuning it is necessary to use the small vernier dial to the left of the tickler dial. After a signal has been tuned in accurately, a further adjustment of the tickler for maximum regeneration will increase the signal strength materially.

Care should be taken not to use too much amplification. If the music or speech being received is sufficiently strong on the first stage of amplification, do not attempt to use more amplification. The use of more amplification would "block" the second amplifier tube and cause local atmospheric disturbances to be amplified in excess of the signal amplification. The blocking of the second tube causes the music or speech to be distorted, the amplification of atmospheric disturbances in excess of the amplification of signal, naturally does not improve the clearness of the music or speech received.

When using the loading coil to secure the wavelength range between 1600 and 2800 meters, the plunger switch is pulled up. To use the set for reception of wavelengths between 180 and 700 meters, the loading coil plunger switch must be pushed down, thereby shortening the loading coils out of circuit.

PLAINTIFFS' EXHIBIT No. 66, Sheet 7. 311–312

AERIOLA SR. RECEIVING SET 187

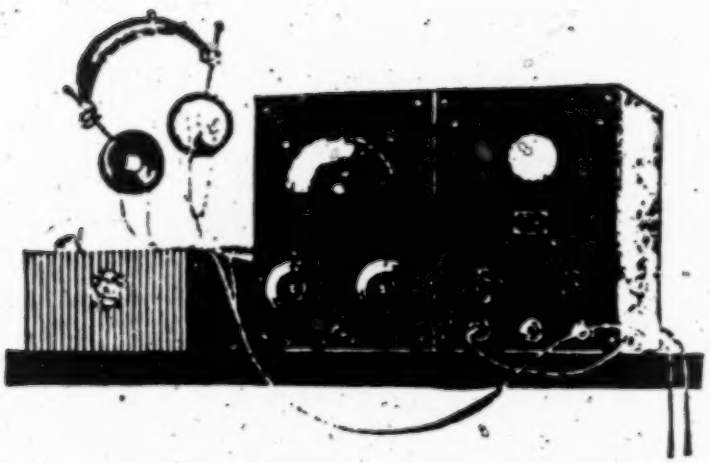
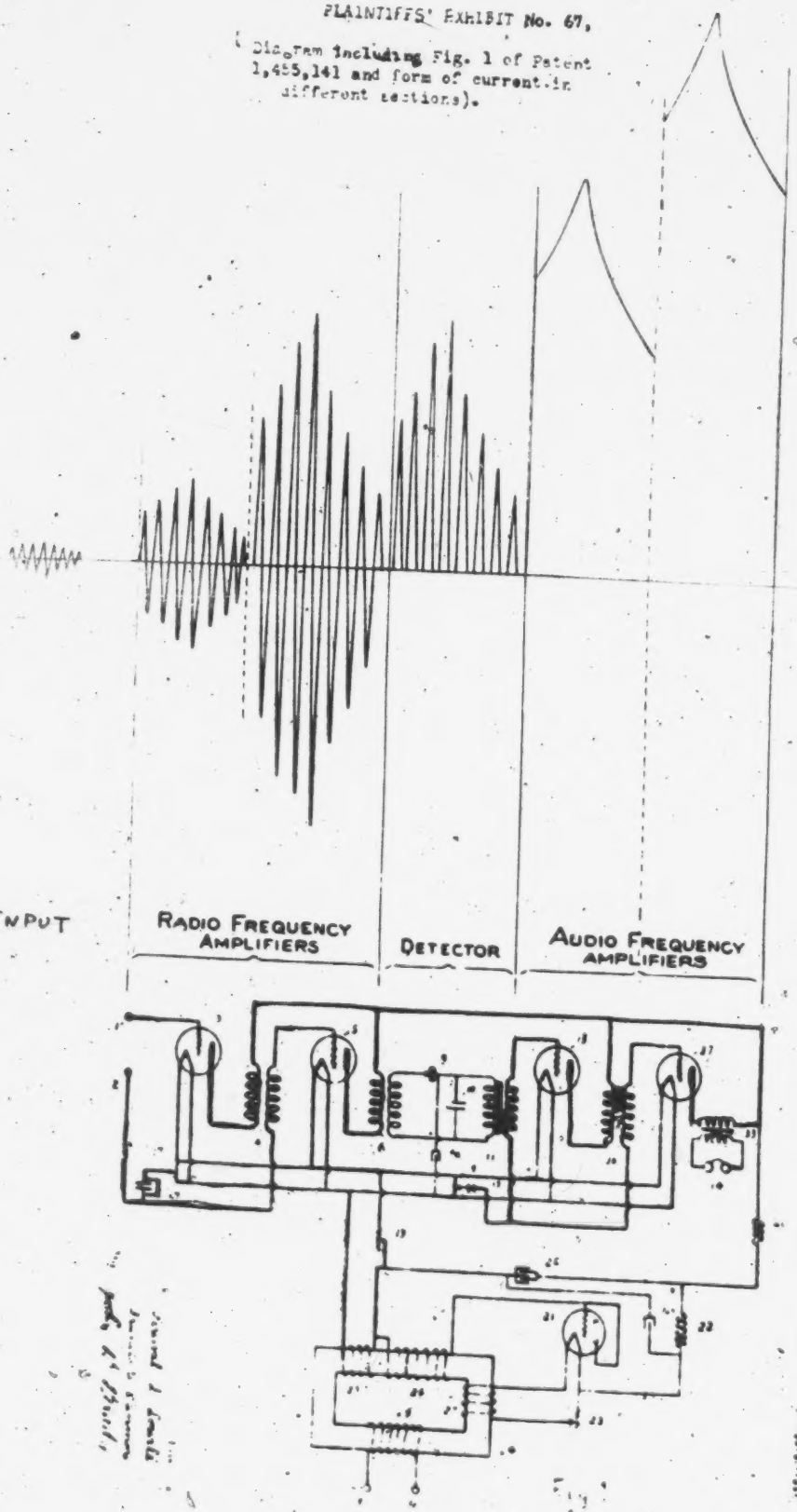


Fig. 61 Westinghouse R. C. Receiving Set

PLAINTIFFS' EXHIBIT No. 67,

Diagram including Fig. 1 of Patent 1,455,141 and form of current in different sections).



U. S. DISTRICT COURT

Plaintiffs' Exhibit No. 16

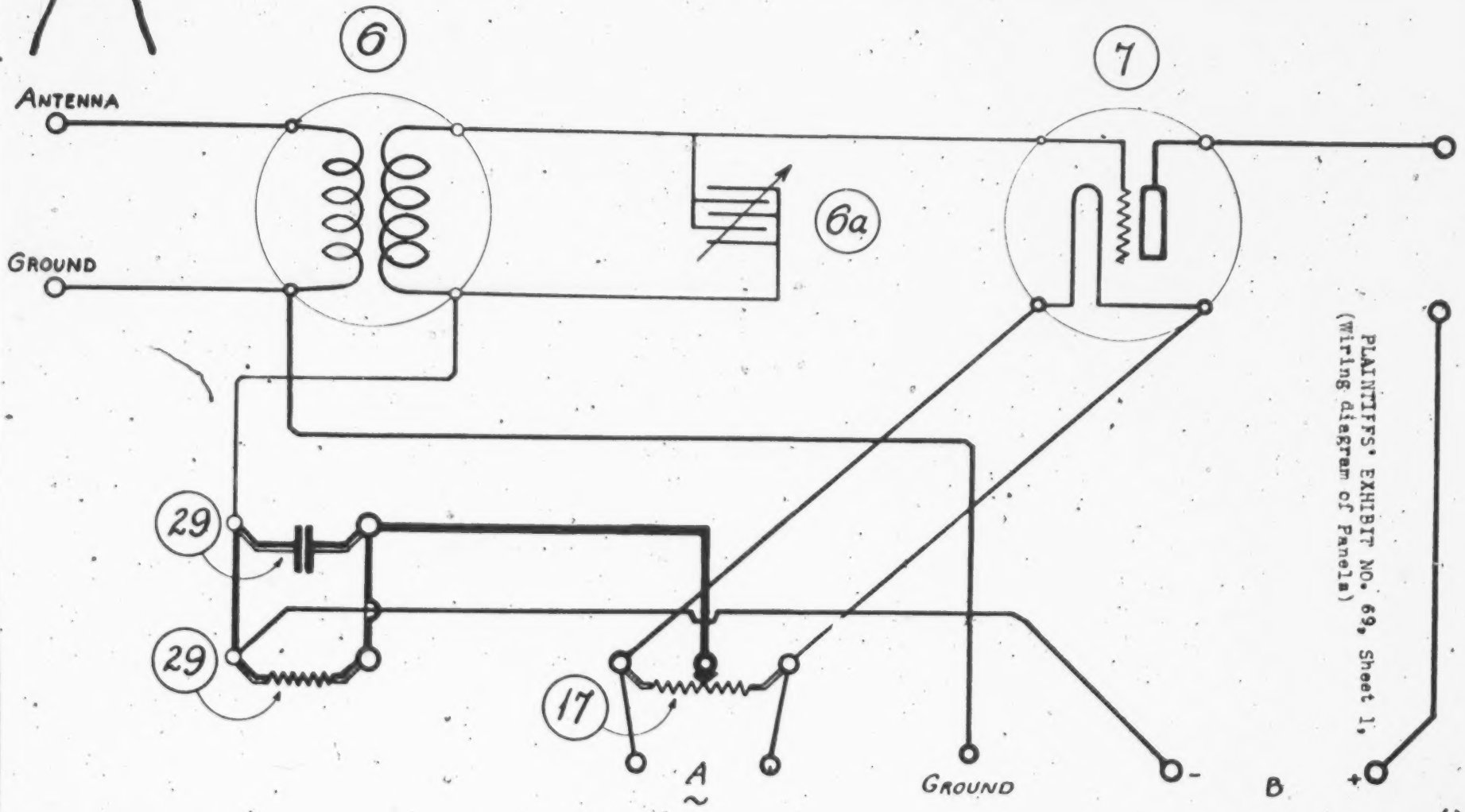
Clerk

May 15, 1923

1,455,141

A

RADIO FREQUENCY AMPLIFIER - ON ALTERNATING CURRENT



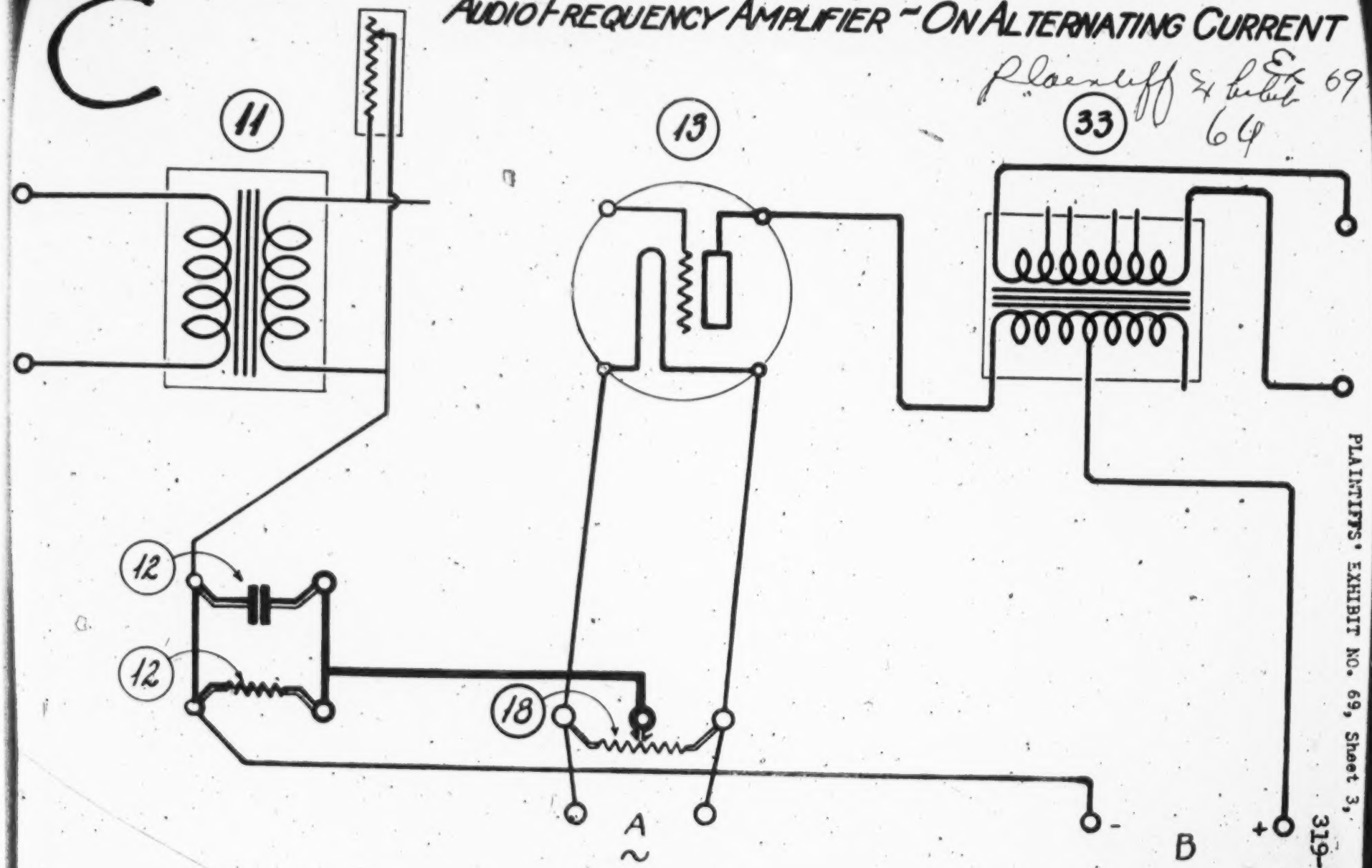
PLAINTIFFS' EXHIBIT NO. 69, Sheet 1,
(Wiring diagram of Panels)

CRYSTAL DETECTOR - ALTERNATING CURRENT USE
PLAINTIFFS' EXHIBIT NO. 69, Sheet 2,
9a
10
-B
8a
9
8
TRAN
B

C

AUDIO FREQUENCY AMPLIFIER ~ ON ALTERNATING CURRENT

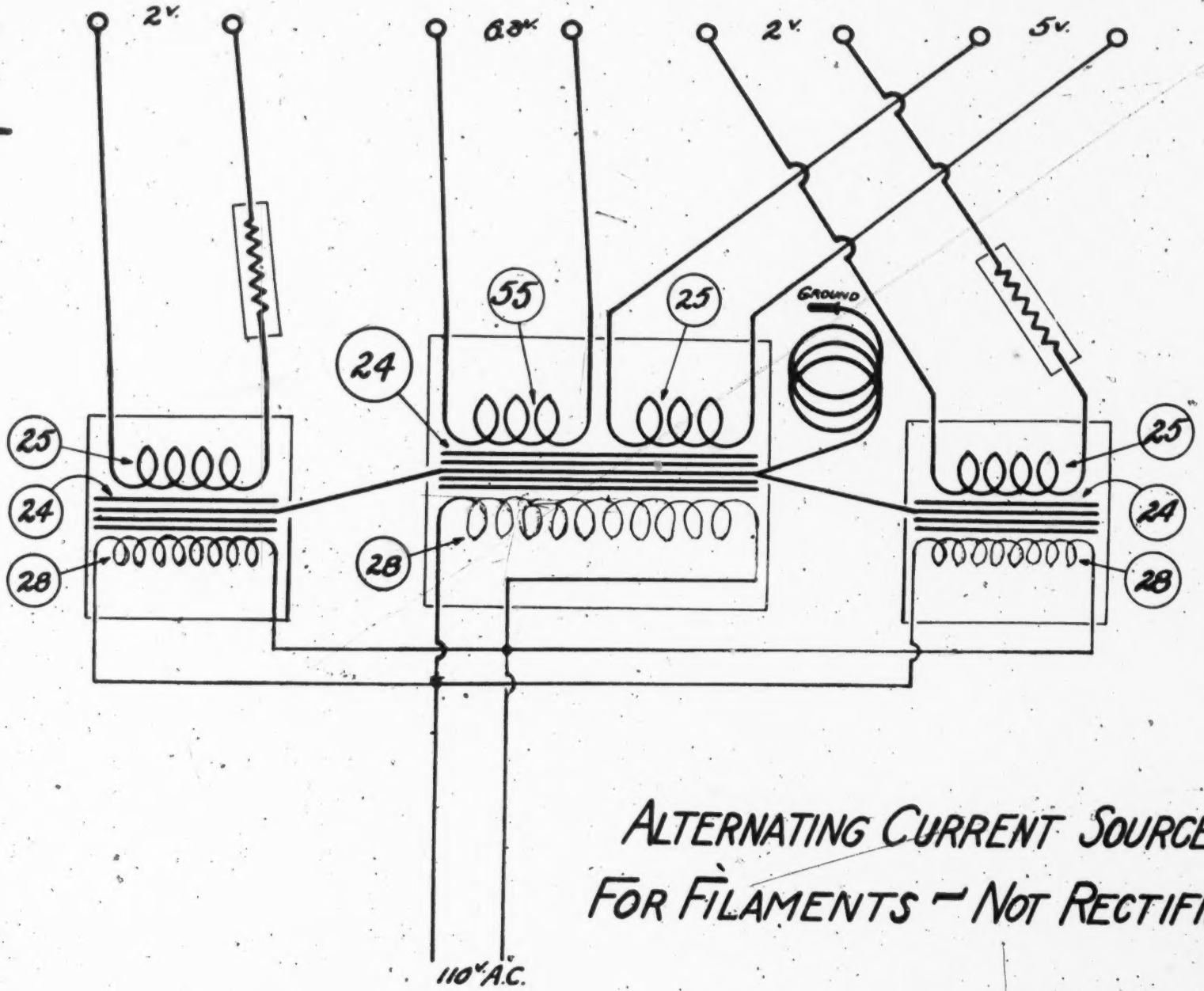
Plaintiffs Ex 69
64



PLAINTIFFS' EXHIBIT NO. 69, Sheet 3,

319-320

E

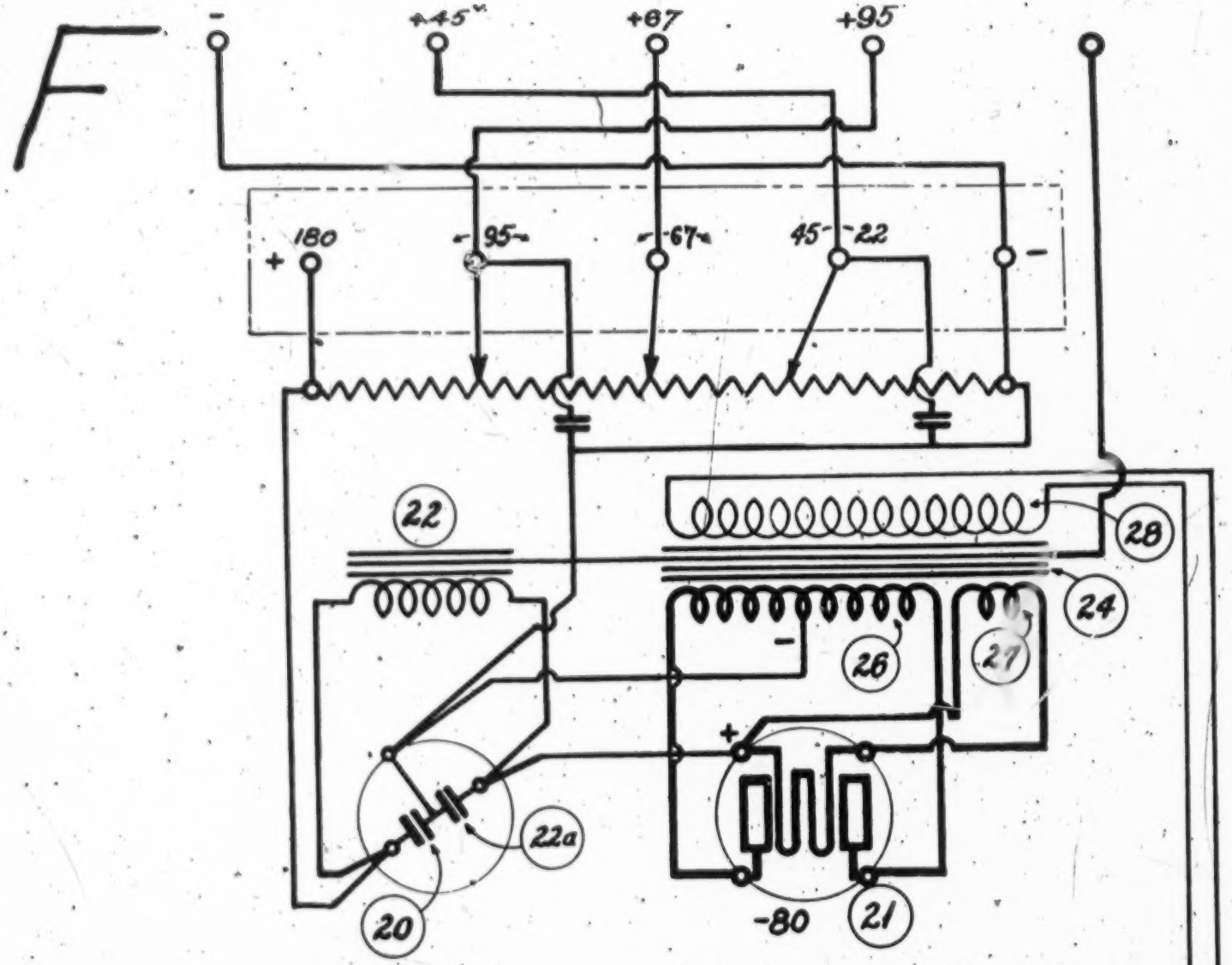


ALTERNATING CURRENT SOURCE
FOR FILAMENTS — NOT RECTIFIED

PLAINTIFFS' EXHIBIT NO. 69, Sheet 4,

321- 322

Ex. 69

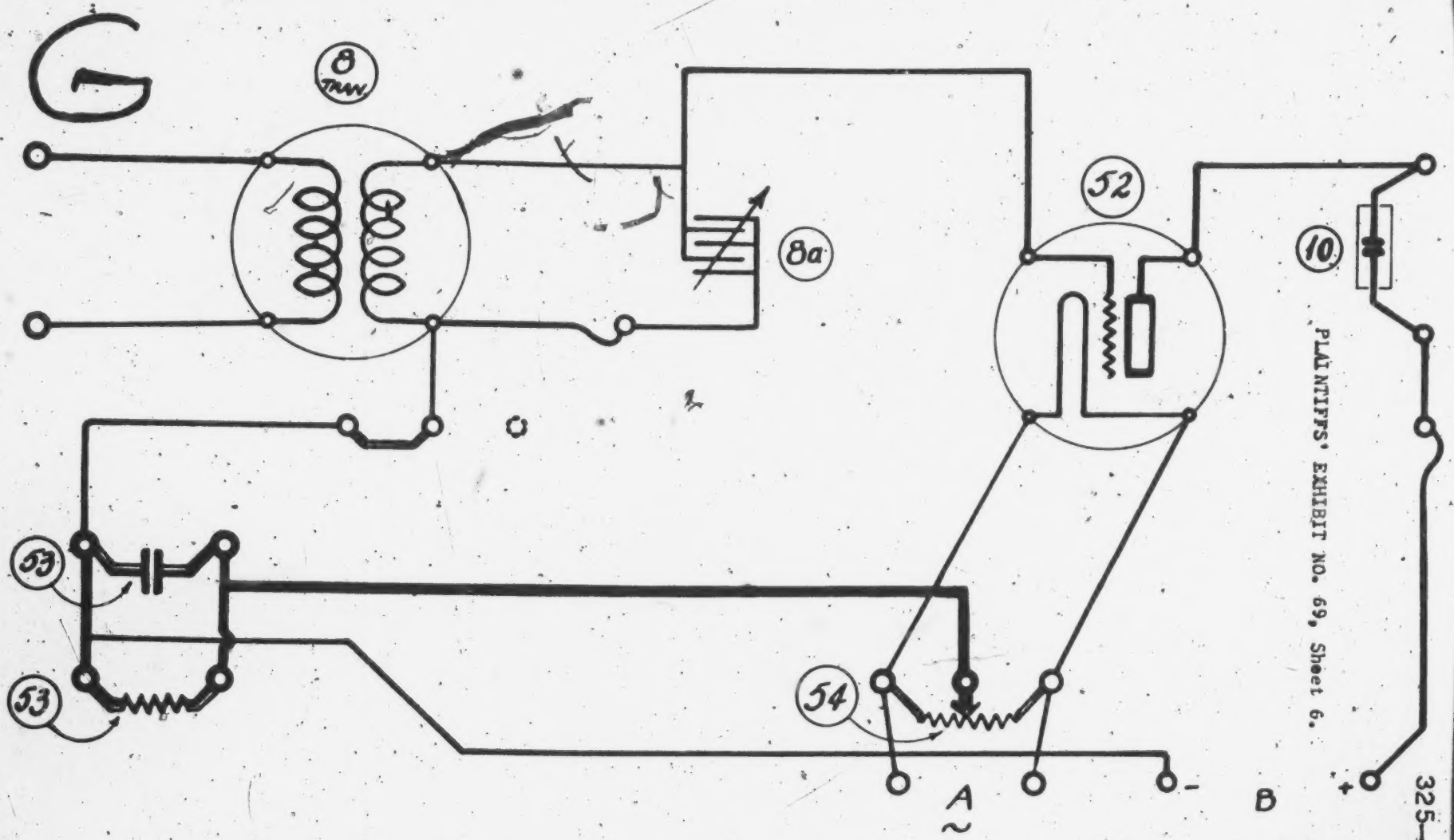


ALTERNATING CURRENT SOURCE FOR PLATES -
RECTIFIED AND FILTERED

PLAINTIFFS' EXHIBIT NO. 69, Sheet 5,

323-824

DETECTOR - ON ALTERNATING CURRENT - USING TYPE - 30 TUBE

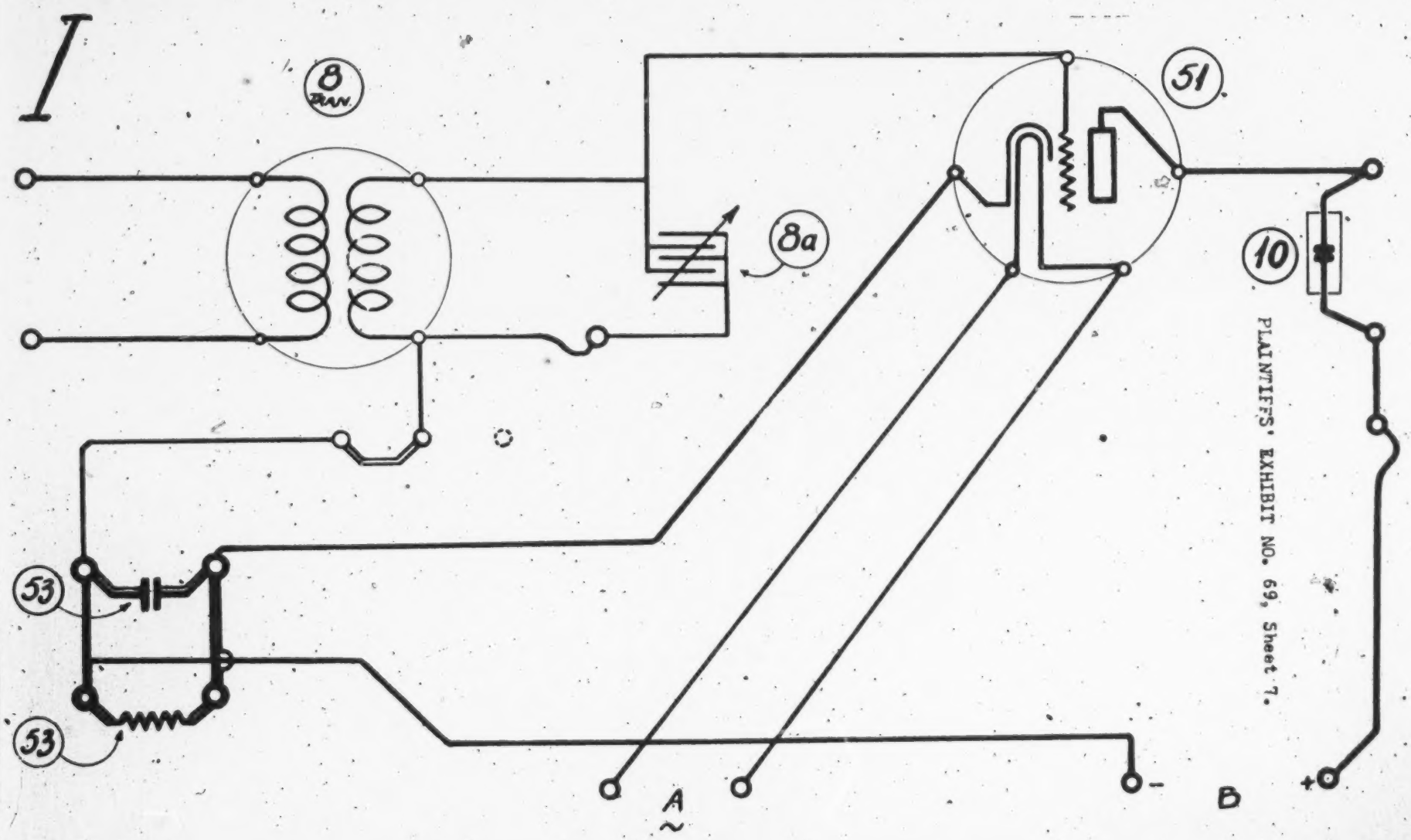


PLAINTIFFS' EXHIBIT NO. 69, Sheet 6.

325-326

DETECTOR - ON ALTERNATING CURRENT - USING TYPE -37 TUBE

Ex. 69



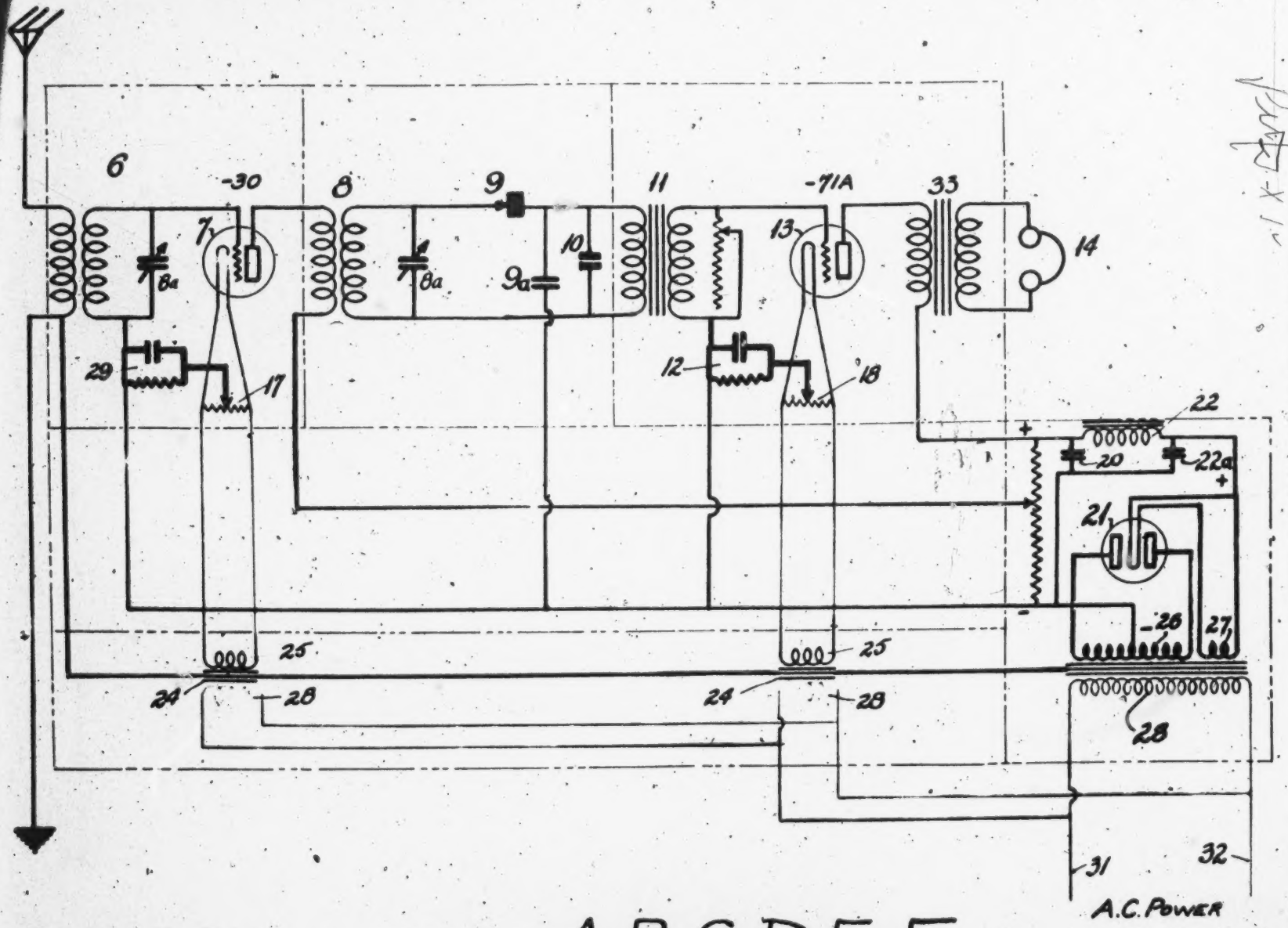
PLAINTIFFS' EXHIBIT NO. 69, Sheet 7.

327-328

ALTERNATING CURRENT SYSTEM — WITH HUM ELIMINATORS — CRYSTAL DETECTOR

Sx 70

Pltf X

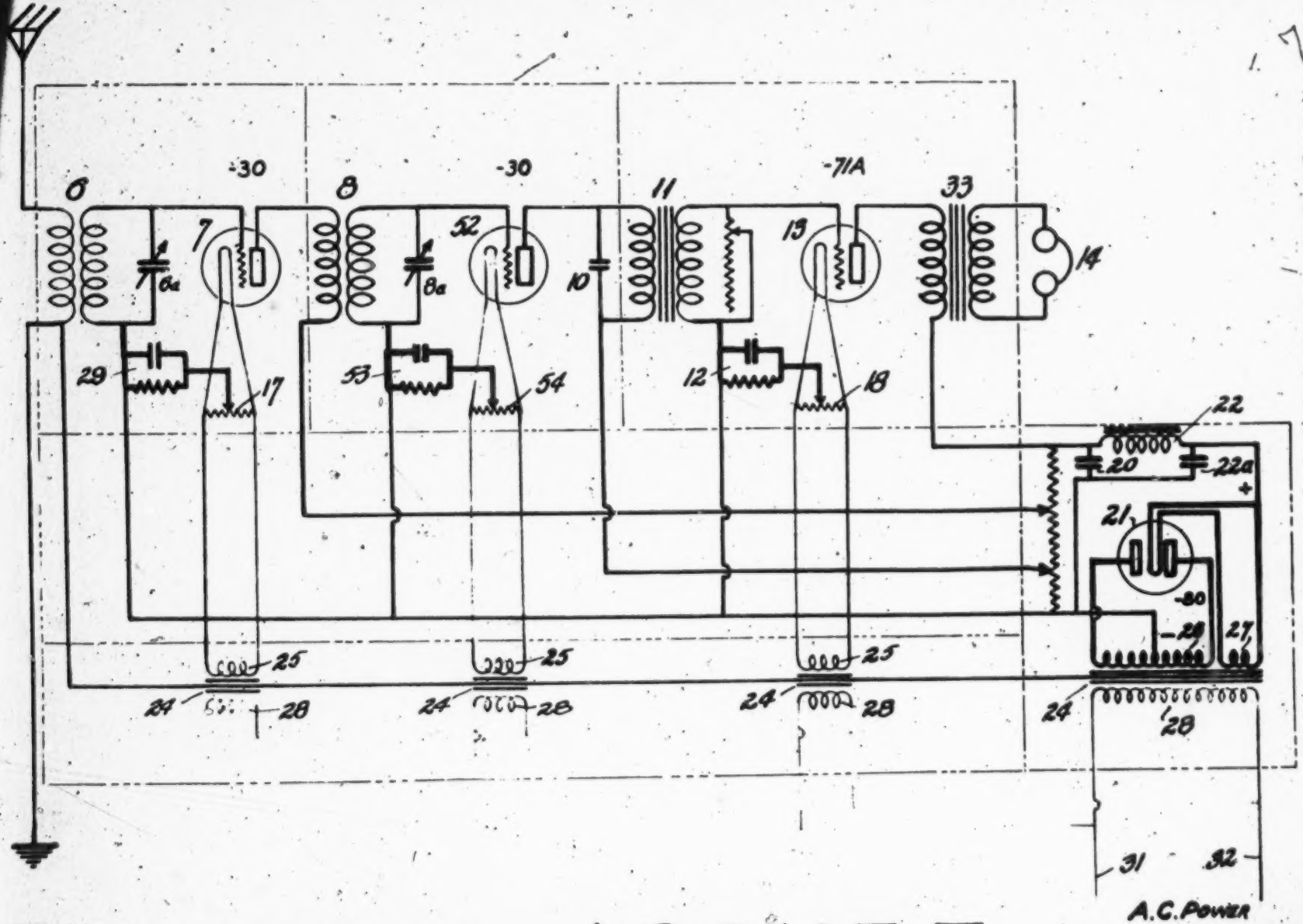


CHARTS A, B, C, D, E, F

PLAINTIFFS' EXHIBIT NO. 70.
(Wiring diagram of Panels, A, B, C, D, E, F, combined)

329-330

ALTERNATING CURRENT SYSTEM – WITH HUM ELIMINATORS – TYPE -30 TUBE DETECTOR



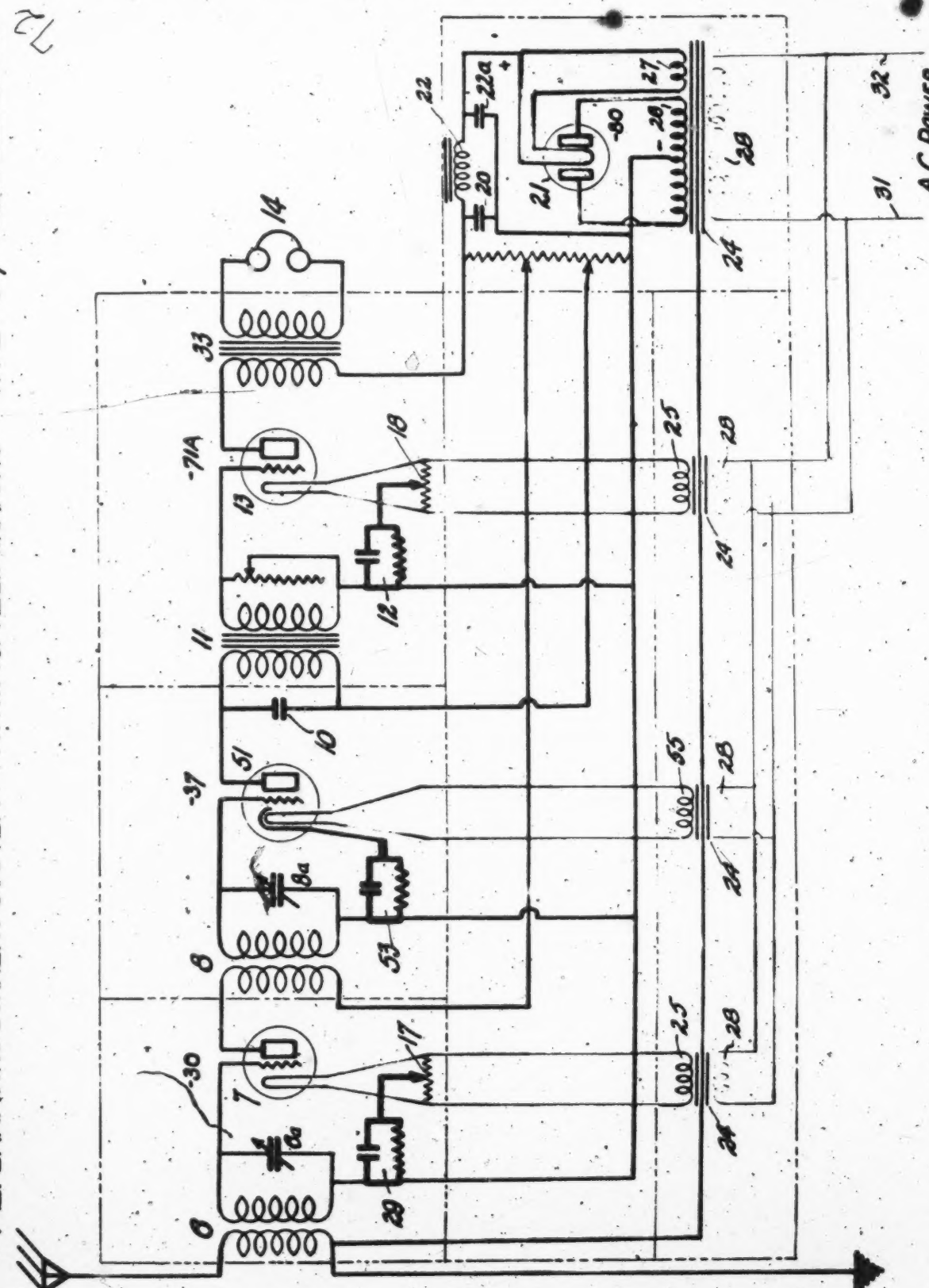
PLAINTIFFS' EXHIBIT NO. 71.
(Wiring diagram of Panels, A, G, C, H, E, F, combined.)

CHARTS A, G, C, H, E, F

331-332

PLAINTIFFS' EXHIBIT NO. 72,
(Wiring diagram of Panels, A, I, C, J, E, F, Combined)

333 - 334



[fols. 335 & 336] PLAINTIFFS' EXHIBIT No. 74

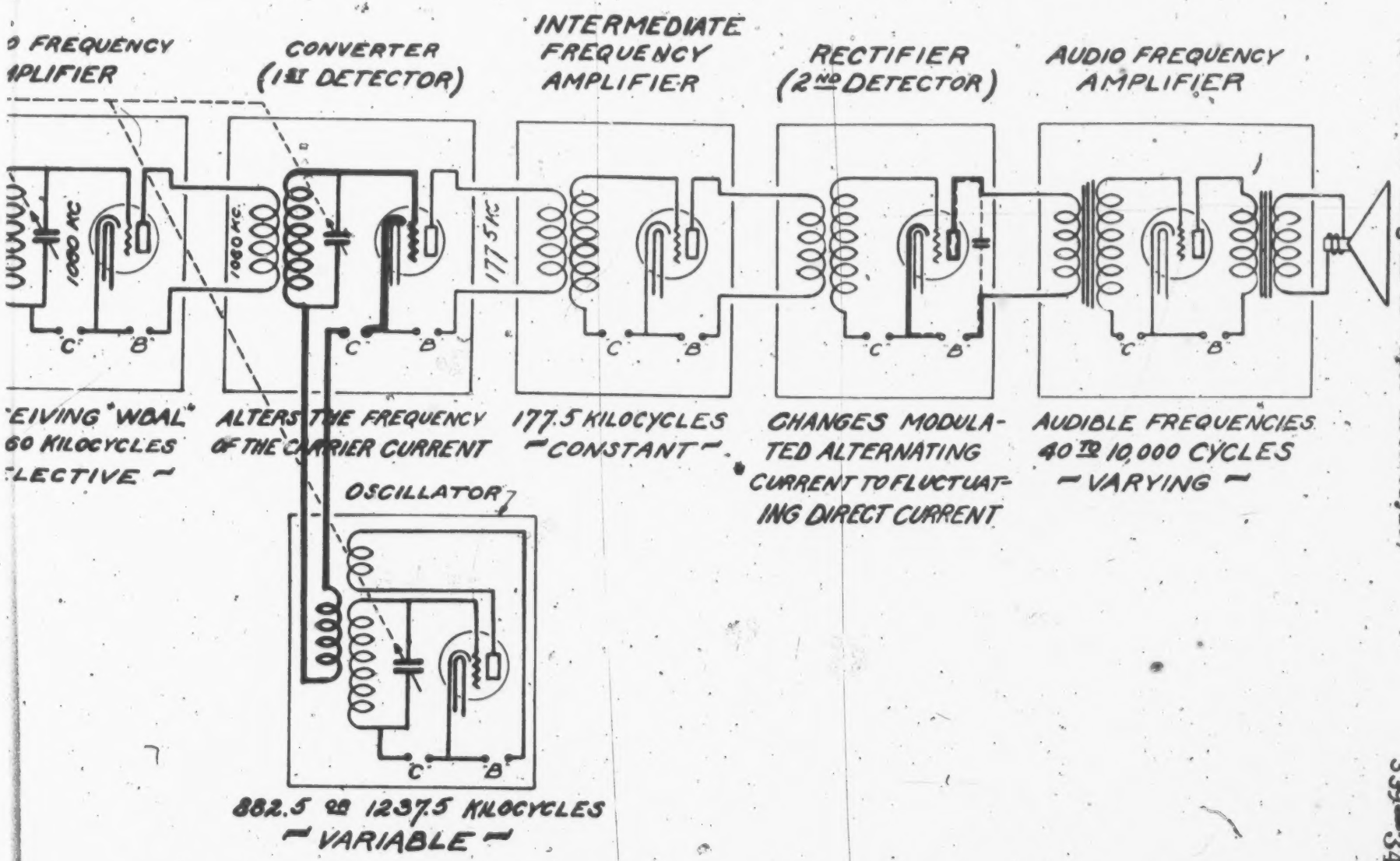
(Stipulation as to Defendants' Circuit)

This Exhibit is the same as Plaintiffs' Exhibit No. 93. And is printed in this Volume of Exhibits at pages 381-382.

[fols. 337 & 338] PLAINTIFFS' EXHIBIT No. 75

(Colored photostats of wiring diagram of Defendants' sets SW 104, 105, 106, 108, 109 are here omitted, the same being attached to Plaintiffs' Exhibits No. 93 and 94, and will be found at pages 383-387-432-408-444 and 466 of this volume of Exhibits.)

THE SUPERHETERODYNE TYPE OF RADIO RECEIVER — NO POWER CIRCUITS SHOWN

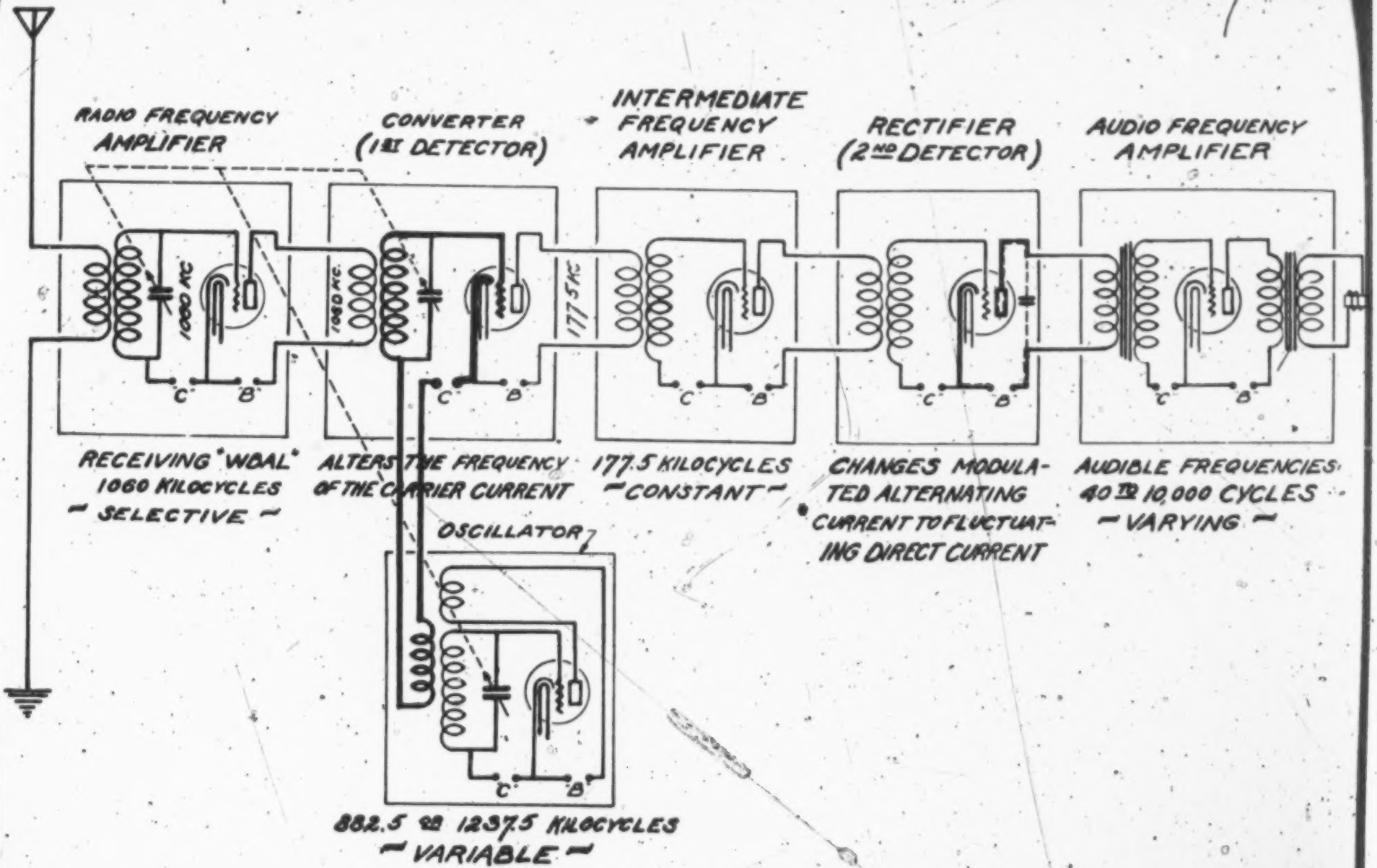


PLAINTIFFS' EXHIBIT No. 76
(Schematic diagram of Super-heterodyne)

339—340

663

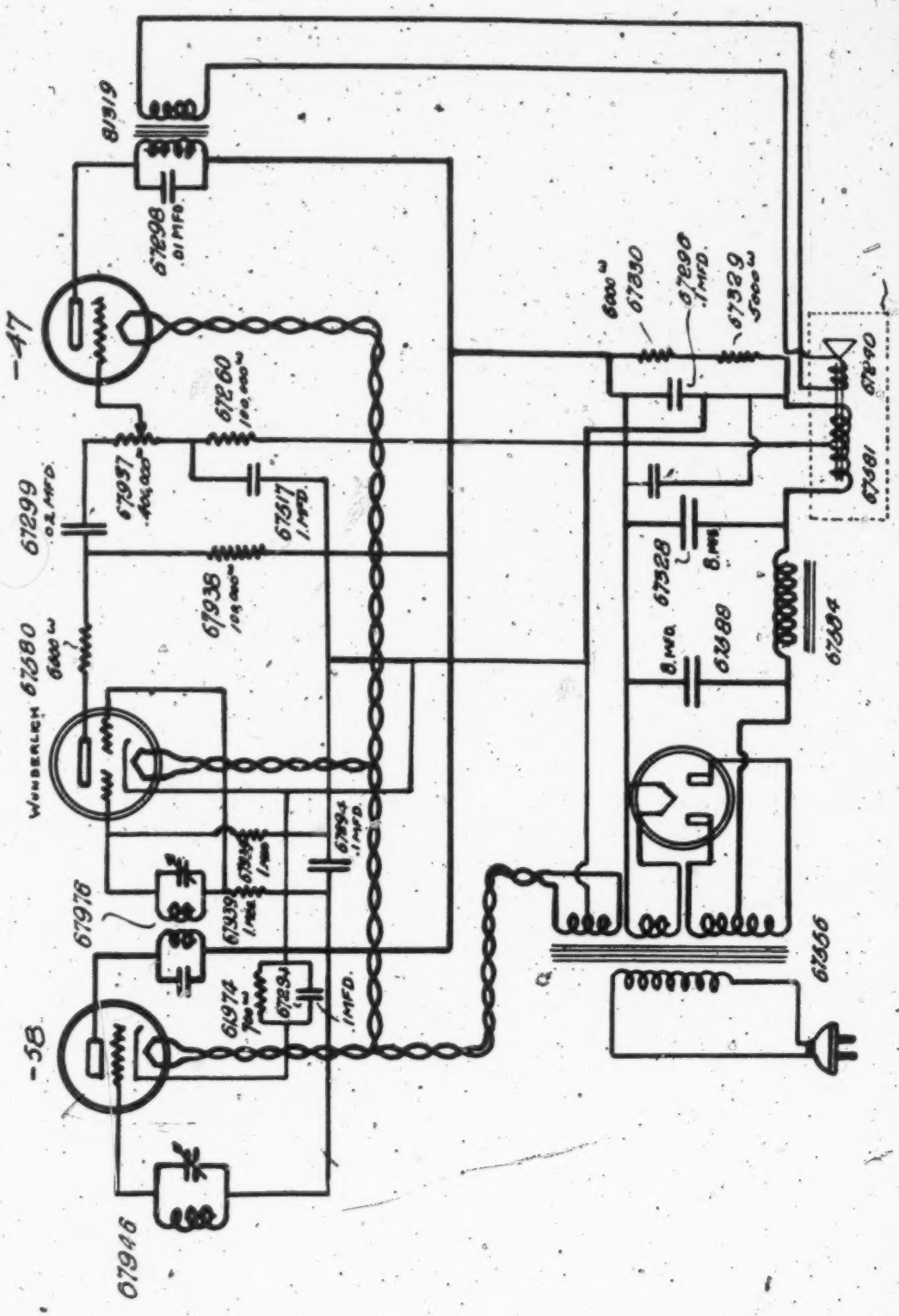
THE SUPERHETERODYNE TYPE OF RADIO RECEIVER — NO POWER CIRCUITS SHOWN



PLAINTIFFS' EXHIBIT NO. 77, Sheet 1.
(Simplified colored diagram of circuits of
Defendants' Set S.W. 104)

Pltf's 77

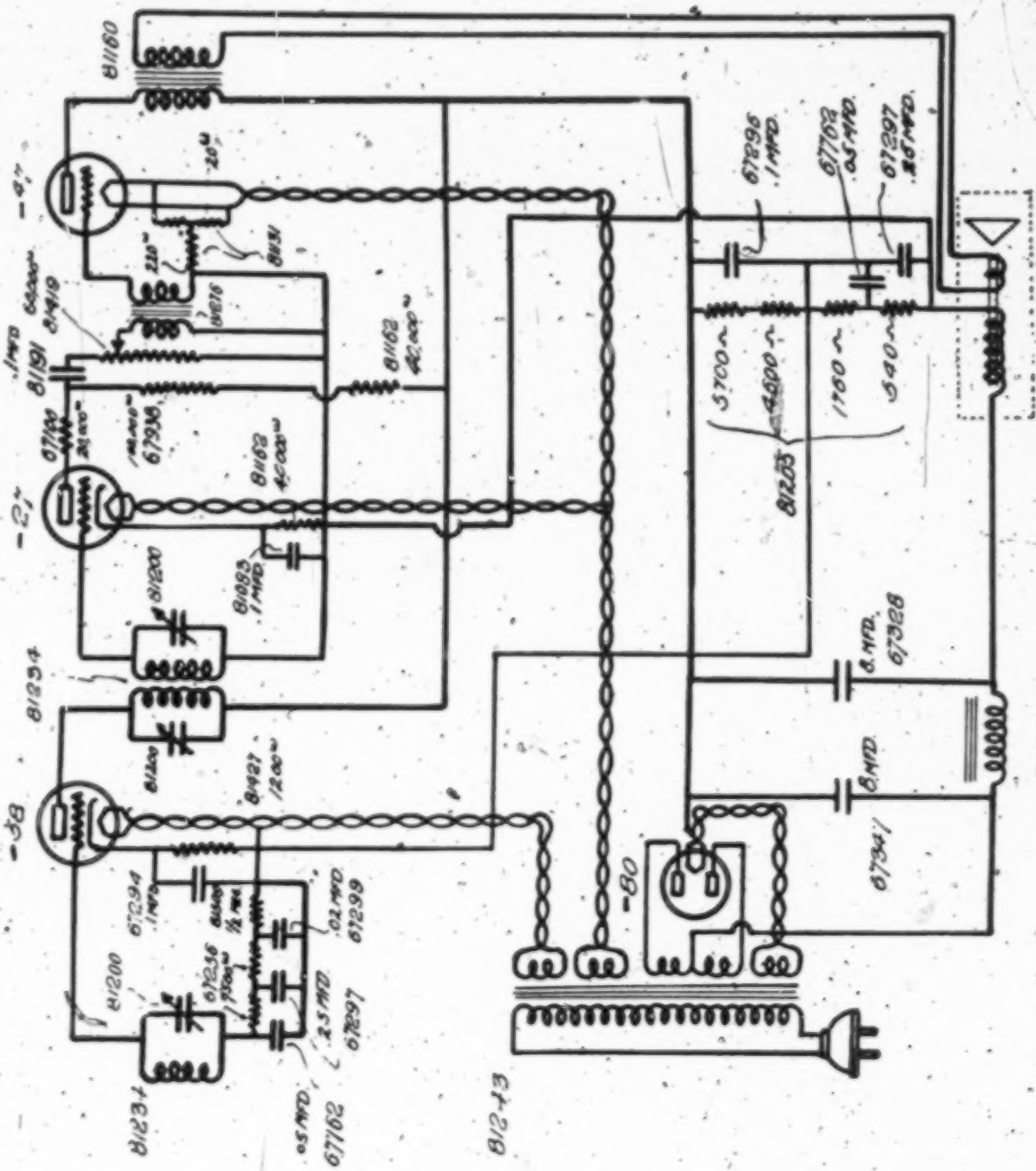
~Stewart-Warner Model 104~



PLAINTIFFS' EXHIBIT No. 77, Sheet 2,
(Simplified colored diagram of circuits of
Defendants' set SW 105)

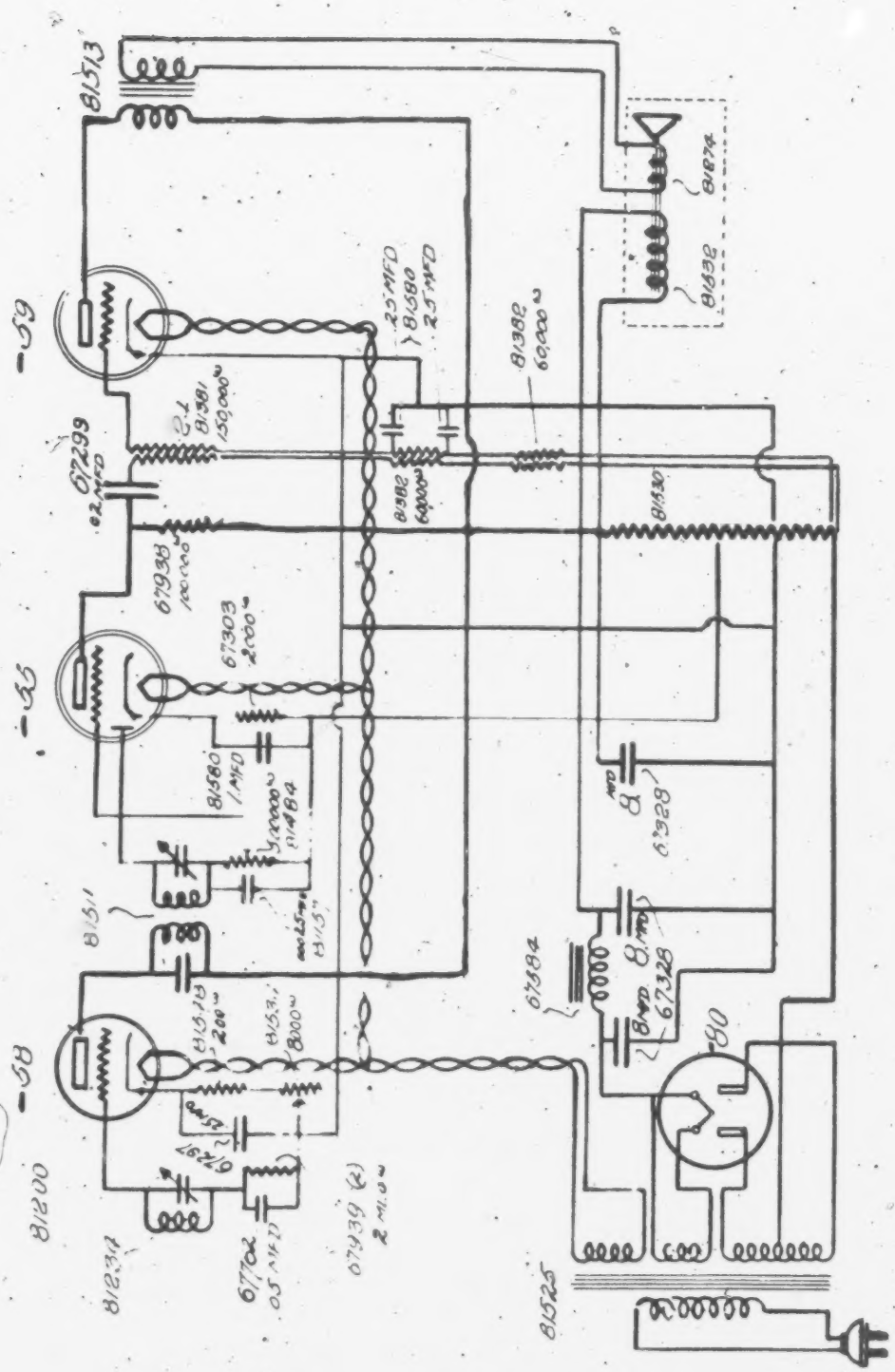
343-344

~ Stewart-Warner Model 105 ~



PLAINTIFFS' EXHIBIT No. 77, Sheet 3,
(Simplified colored diagram of circuits of
Defendants' Set SW 105.)

~ Stewart-Warner Model 105 ~

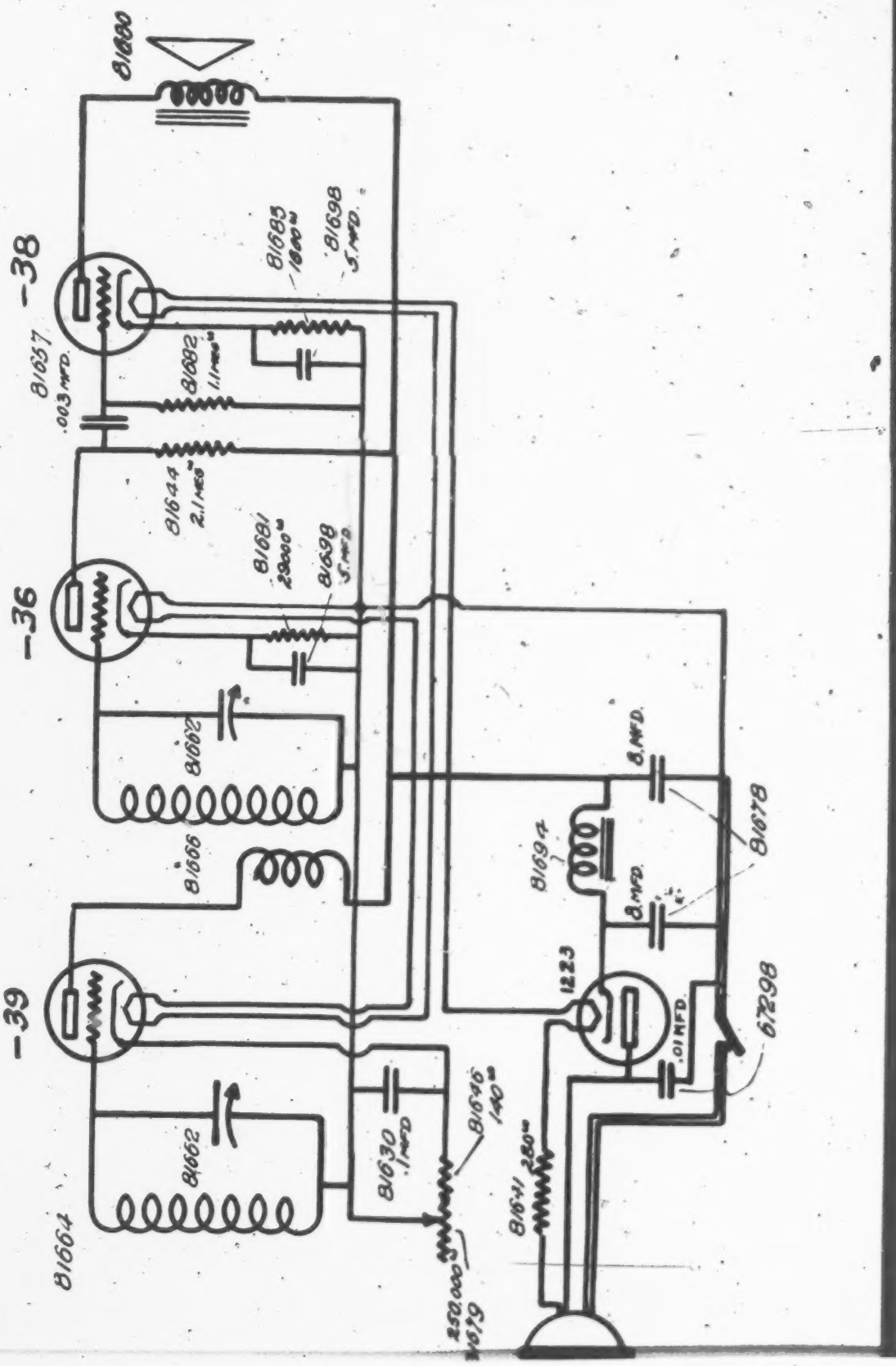


PLAINTIFFS' EXHIBIT No. 77, Sheet 4;
(Simplified colored diagram of circuits of
Defendants' Set SW. 108).

347 — 348

Rtg x 77

~ Stewart-Warner Model 108 ~

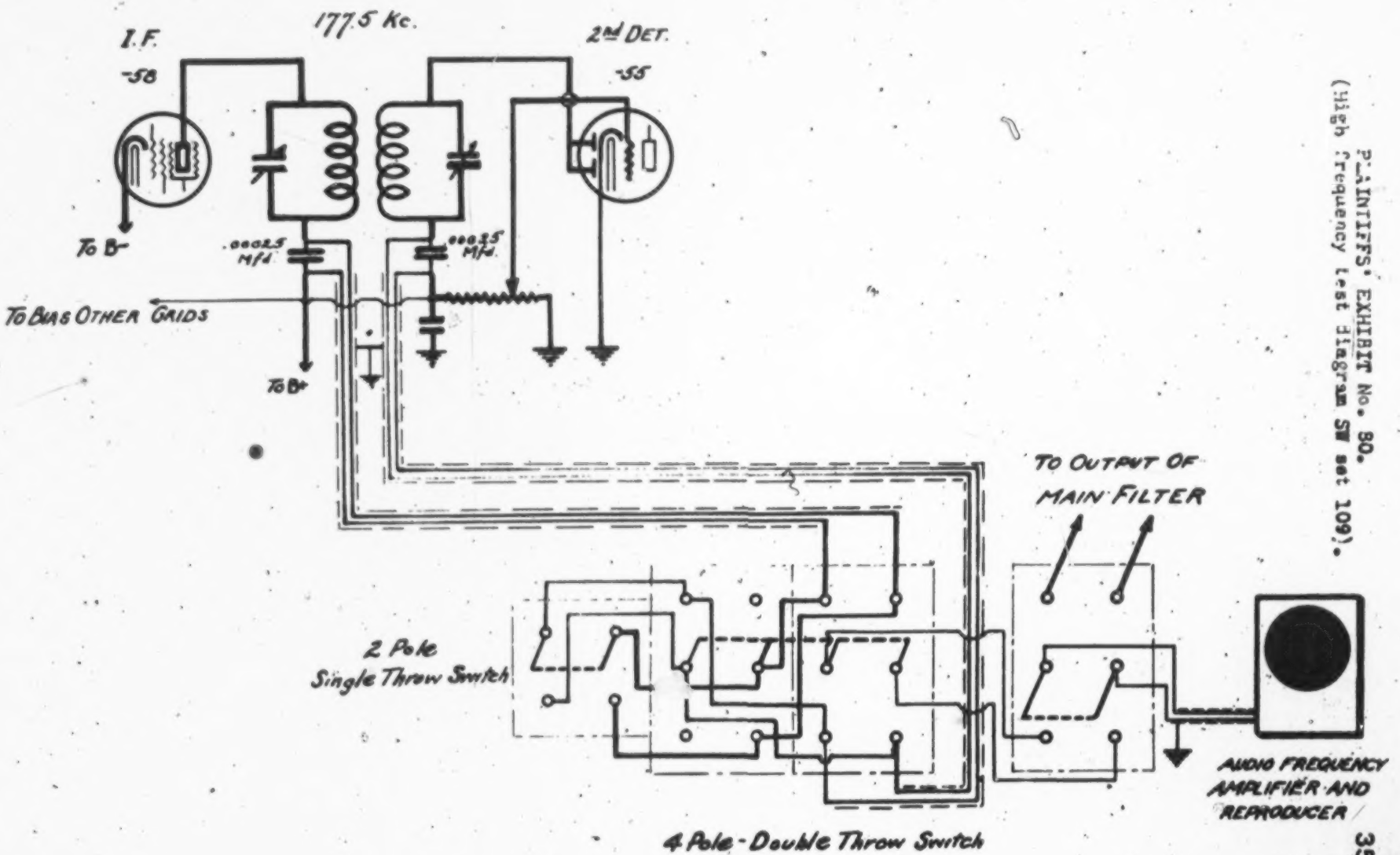


[fols. 349 & 350] PLAINTIFFS' EXHIBIT No. 79

(Filter test diagram SW set 109)

This exhibit was also offered as Plaintiffs' Exhibit No. 109 and will be found at page 536 of this Volume of Exhibits.

STEWART-WARNER MODEL 109 - ARRANGED FOR TEST IN LAST HIGH FREQUENCY CIRCUIT



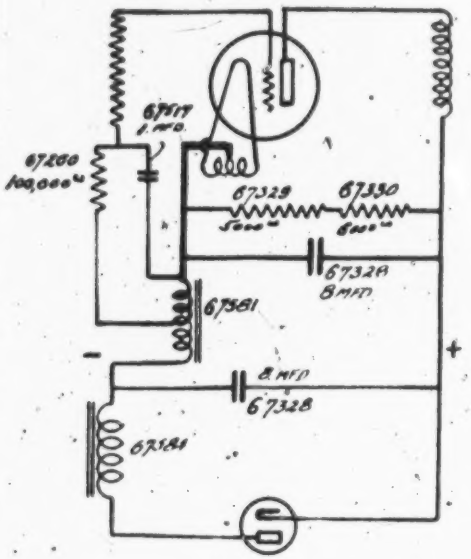
PLAINTIFFS' EXHIBIT No. 80.
(High Frequency Test Diagram SW set 109).

621

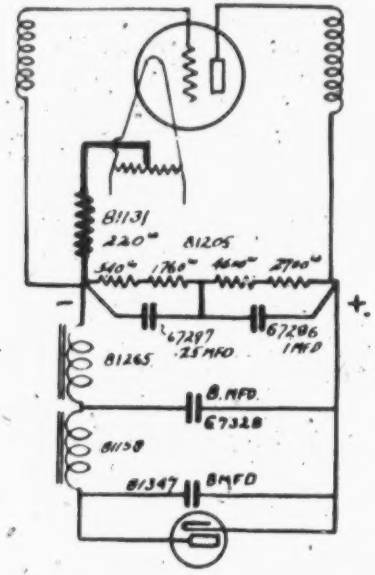
AUDIO FREQUENCY AMPLIFIER CIRCUITS IN STEWART-WARNER MODELS

REFER to DUNMORE PATENT 1635117

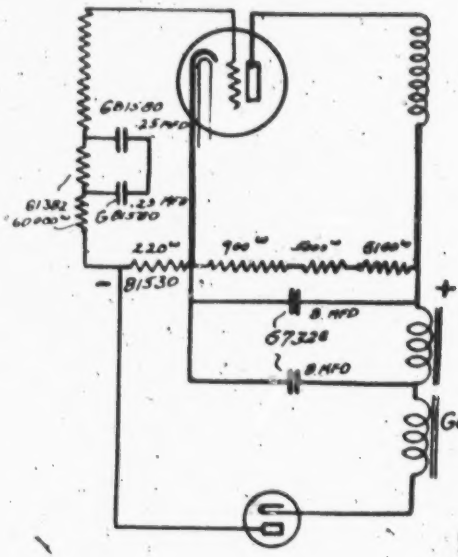
MODEL 104



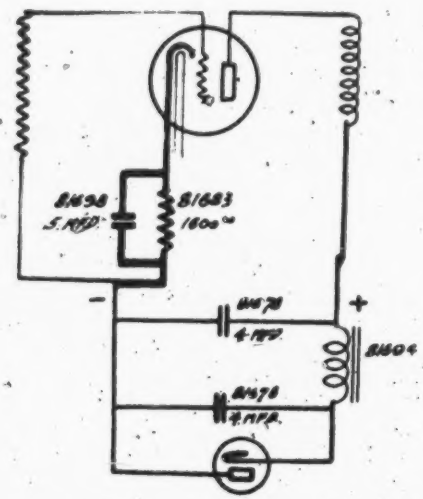
MODEL 105



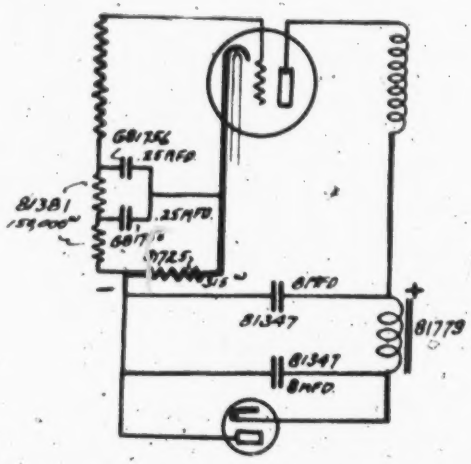
MODEL 106



MODEL 108



MODEL 109



PLAINTIFFS' EXHIBIT No. 81.
(Grid bias diagrams of sets 104, 105, 106, 108 and 109.)

PLAINTIFFS' EXHIBIT No. 84, Sheet 1.
8 Sheets of
(Pencil description of AC amplifier made by Lowell at Arcade Bowling Alleys).

355–356

RADIO RECEIVING AMPLIFIER

(1)

The device here described and illustrated by circuit diagrams is a radio receiving amplifier, wherein both the radio and audio frequencies currents are amplified by means of electron tubes, a crystal detector used as a rectifier, the necessary filament and plate voltages being supplied by the standard 110 volt, 60 cycle lighting power, the residual hum in the telephone receivers being balanced out or neutralized by means of voltage dividers or other devices as will be explained.

Fig. 1 shows an amplifier circuit with two radio frequency stages, a crystal detector and two audio frequency stages. The filaments of all the tubes are connected in parallel and are lighted by A.C. voltage supplied from the secondary windings of the transformer ——/\—— The primary winding of transformer ——o o—— is shown at

their brilliancy being controlled by the rheostat —

RADIO RECEIVING AMPLIFIER

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Fig. 1 shows an amplifier circuit with two radio frequency stages, a crystal detector and two audio frequency stages. The filaments of all the tubes are connected in parallel and are lighted by A.C. voltage supplied from the secondary windings of the transformer ——, their brilliancy being controlled by the rheostat —. The primary winding of transformer —— is shown at ——, the 110 volt, 60 cycle power being connected to the terminals —— and ——.

PLAINTIFFS' EXHIBIT NO. 84, Sheet 2. 357-358

(2)

Winding — of transformer — supplies high voltage A.C., which is rectified by the electron tube —, smoothed ~~to condenser — about 4 microfarads capacity, and choke coil —~~ out by choke coil — and condenser —, which is about 4 microfarads capacity. This provides a high voltage direct current which is suitable for the plates of the amplifier tubes. The filament of the rectifier tube — is lighted from winding — of transformer —, the rheostat — ~~serving the double purpose of~~ varies the brilliancy of the rectifier filament, which in turn controls the D.C. voltage output.

The input terminals to the amplifier are shown at — and —, — being connected to the grid of tube — and — being connected to the slider of ~~the~~ balancing resistance — through battery —, ~~which increases a negative voltage on the~~

Winding — of transformer — supplies high voltage A.C., which is rectified by the electron tube —, smoothed ~~through condenser —, adjusted to proper~~ ~~capacity, and choke coil —~~ out by choke coil — and condenser —, which is about 4 microfarads capacity. This provides a high voltage direct current which is suitable for the plates of the amplifier tubes. The filament of the rectifier tube — is lighted from winding — of transformer —, the rheostat — ~~serving the double purpose of~~ varies the brilliancy of the rectifier filament, which in turn controls the D.C. voltage output.

The input terminals to the amplifier are shown at — and —, — being connected to the grid of tube — and — being connected to the slider of ~~the~~ balancing resistance — through battery —, which impresses a negative voltage on the grid, making the tube more suitable for amplifying. This balancing resistance is

(3)

about 200 ohms and is connected directly across the [redacted] filament line and serves to keep [redacted] the grid voltage steady with respect to the filament voltage.

The plate circuit of tube — is coupled to the grid circuit of tube — by means of the radio frequency transformer —. There is some variation in the plate current of tube — due to the periodic variation in filament temperature but the resultant audio frequency hum does not pass thru the radio frequency coupling of transformer — and [redacted] does not reach the input of tube —

The secondary of rader transformer — is connected to [redacted] grid of tube — and to slider of balancing resistance — thru battery —, the former keeping the grid voltage steady and the latter impressing a negative charge on the grid in

about 200 ohms and is connected directly across the filament line and serves to keep the grid voltage steady with respect to the filament voltage.

The plate circuit of tube — is coupled to the grid circuit of tube — by means of the radio frequency transformer —. There is some variation in the plate current of tube — due to the periodic variation in filament temperature but the resultant audio frequency hum does not pass thru the radio frequency coupling of transformer — and does not reach the input of tube —

The secondary of radio transformer — is connected to grid of tube — and to slider of balancing resistance — thru battery —, the former keeping the grid voltage steady and the latter impressing a negative charge on the grid in the same manner as in tube —.

(4)

In the plate circuit of tube — is the primary of radio frequency transformer — in the secondary of which is a crystal detector and the primary of audio frequency transformer — shunted with by-pass condenser —. The secondary of this audio transformer is connected to the grid of tube — and to slider of balancing resistance — thru battery — in the same manner as tubes — and —. Another audio frequency stage is added in the same manner and is indicated by transformer — and tube —. The telephone receivers are connected inductively to the plate circuit of tube — by means of transformer — which has a 1 to 1 ratio of winding.

By adjusting the balancing rheostat — the voltage of all the grids are simultaneously kept at a steady value and the battery — provides the proper

negative voltage to all the grids for the best amplification.

Figure 2 shows a modified form of circuit wherein the grid battery — is replaced by the condenser — shunted by a leak resistance. The capacity of this condenser is about .02 microfarads and is inserted in series with the grid circuits of the radio frequency amplifier tubes — and —. With this condenser in the circuit as shown, the grids assume a normal voltage suitable for amplifying while the balancing resistance — neutralizes effect of the A.C. on the filaments. The leak resistance across condenser — any super charge on the grids to leak off to the filaments.

In a similar manner, the grid circuits of the audio frequency amplifier tubes and are connected to the sliders of balancing resistance — through condenser and leak — and to

(6)

~~resistance~~ slider of balancing resistances — thru condenser and leak —. Both condensers — and — are about .02 microfarads capacity.

The ~~purpose~~ of the ~~2~~ condensers

[redacted]

— and — is to allow the grids of tubes — and — to assume a normal voltage suitable for amplifying ~~and~~ while the balancing resistances — and — serve to keep the grid voltages steady with respect to the filaments.

In series with the plate circuits of tubes — and — are condensers — and — of about .02 microfarads capacity shunted by resistances of about 80,000 ohms. The action of these condensers is to partially block the low frequency fluctuations in plate current, caused by the ~~the~~ periodic change in filament temperature, while the higher frequencies

(7)

pass thru more easily. The 80,000 resistances allow the ~~plate~~ high voltage to flow to the plates. On the secondary of the telephone transformer — and in series with the telephone receivers — is shown a condenser — of about .02 microfarads capacity which partially blocks any low frequency hum from flowing into the telephone circuit but which allows the higher frequencies to pass through more easily. The source of filament current and plate voltage is ~~#~~ obtained from transformer — and tube rectifier — in the same manner as described for Fig. 1.

In either of these circuits, instead of the balancing resistance across the filament line, a divided condenser circuit may be provided and a connection taken from the center thereof

PLAINTIFF'S EXHIBIT NO. 84, Sheet 8. 369-370

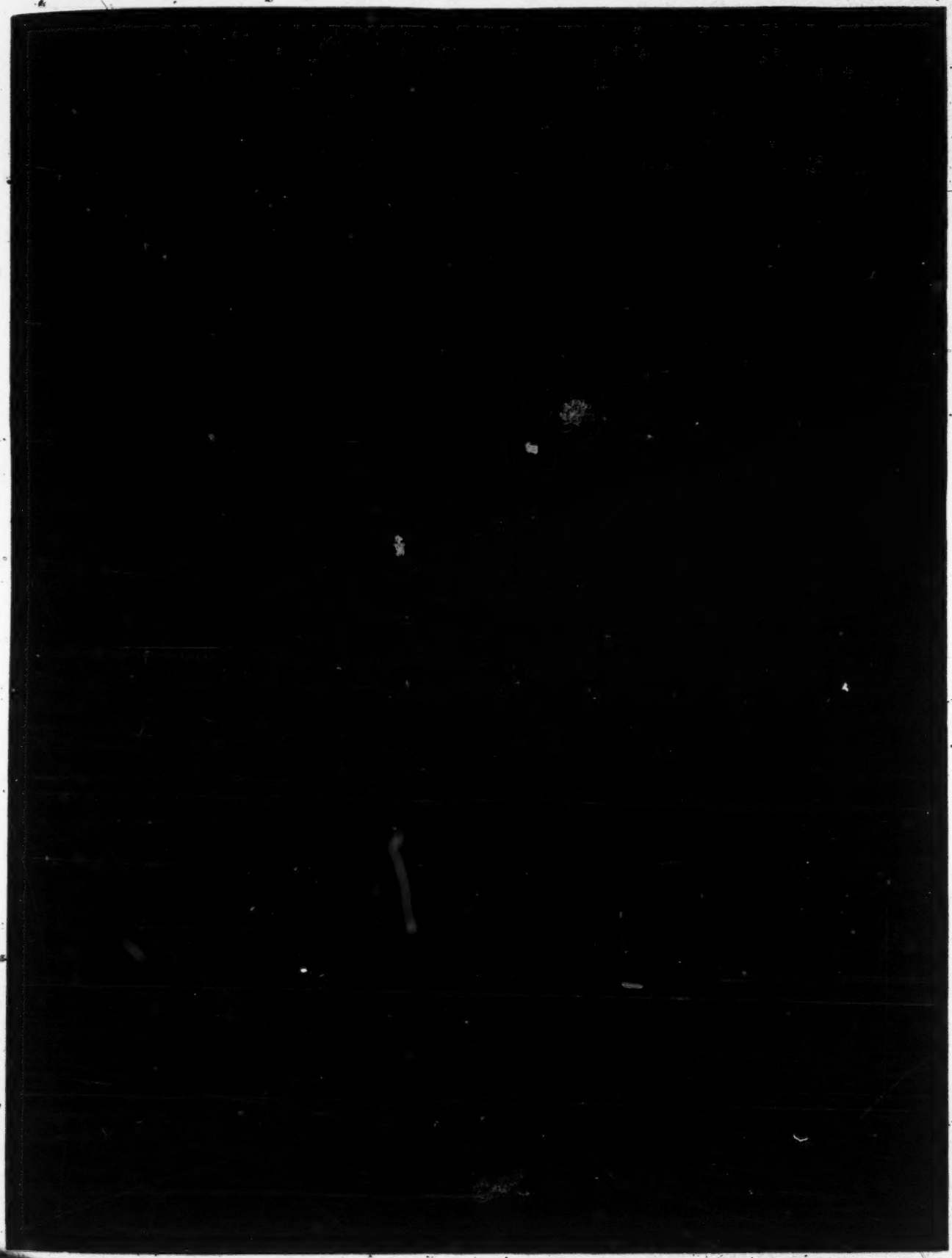
(2

to the grid circuit, or the
filament current winding on the
transformer — may be tapped
at its electrical center and lead
to the grid circuit

PLAINTIFFS' EXHIBIT No. 85.

371-372

(Photograph of Bureau of Standards AC set with Lowell)



PLAINTIFFS' EXHIBIT No. 90

(Patent 1,606,212 to Dunmore & Lowell)

683 Nov. 9, 1926. 1,606,212

F. W. DUNMORE ET AL

POWER AMPLIFIER

Filed March 21, 1922

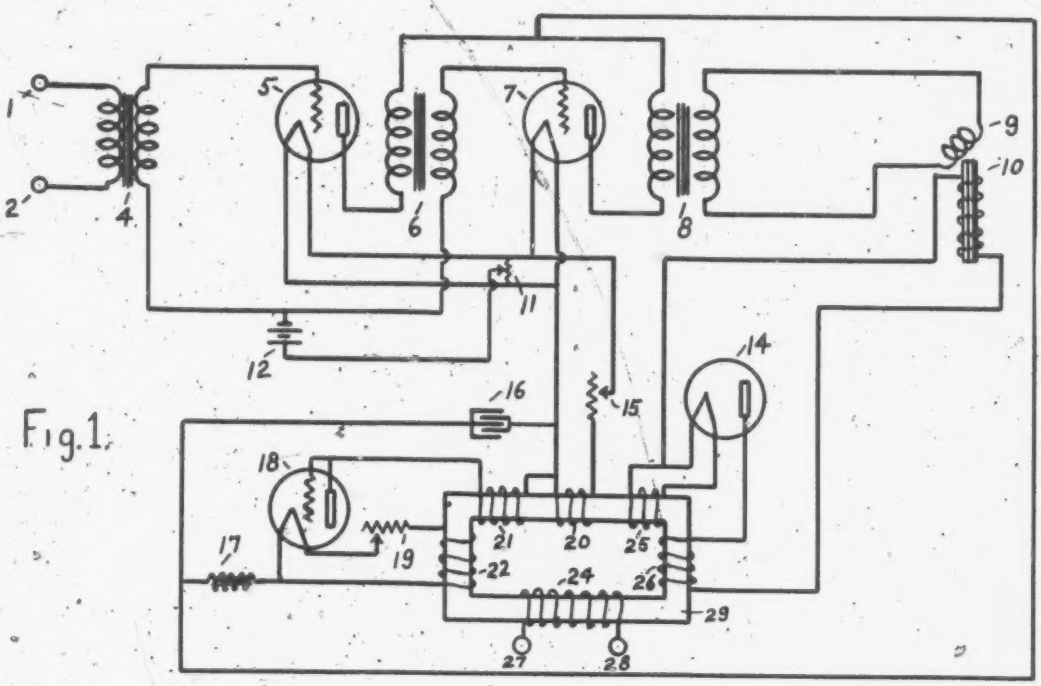


Fig. 1.

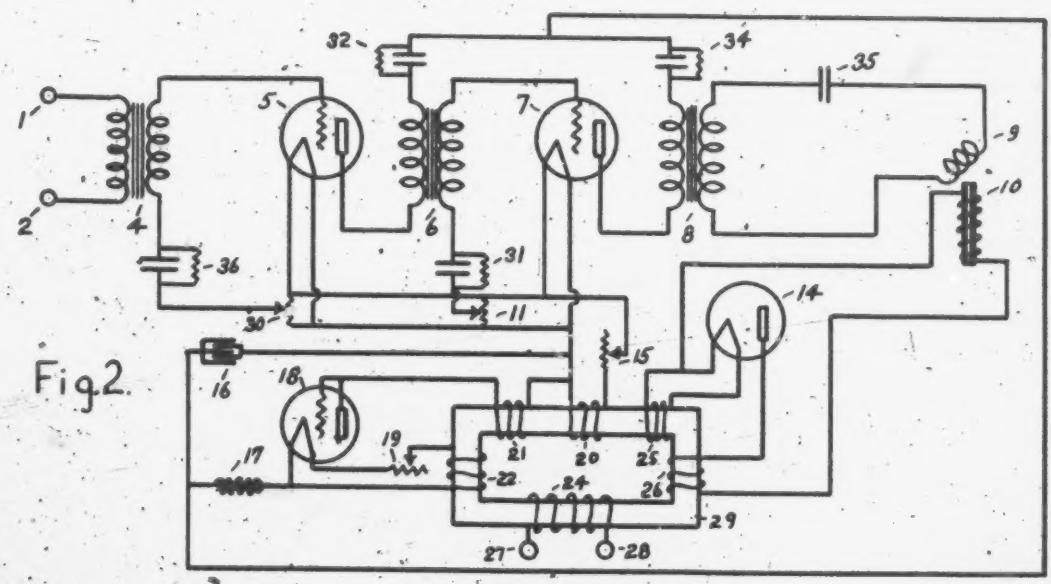


Fig. 2.

Inventor

Francis W. Dunmore.

Percival D. Lowell.

By John B. Brady

Attorney

Patented Nov. 9, 1926. 1,606,212

UNITED STATES PATENT OFFICE.

FRANCIS W. DUNMORE AND PERCIVAL D. LOWELL, OF WASHINGTON, DISTRICT OF COLUMBIA.

POWER AMPLIFIER.

Application filed March 21, 1922. Serial No. 545,493.

Our invention relates to apparatus for the amplification and reproduction of sounds by electrical means and more particularly to an amplifying unit and reproducer of electrical signals.

The object of our invention is to provide an amplifier and reproducer in the form of a readily portable unit.

Another object of our invention is to provide an amplifier of the thermionic vacuum tube type with circuit arrangements for operating the apparatus from the usual source of alternating current residence power supply for energizing the vacuum tube circuits without the use of primary or secondary batteries.

A further object of the invention is to provide a circuit arrangement for a thermionic vacuum tube amplifier employing a loud speaking reproducer in which the loud speaker has its field winding energized from a source of residence lighting power without the use of primary or secondary batteries.

A still further object of the invention is to provide means for eliminating the hum of the low frequency alternating current power supply in the circuits of the thermionic vacuum tube amplifier and reproducer.

Another object of the invention is to provide means for rectifying alternating current and smoothing out the rectified energy to provide a source of power for the circuits of the thermionic vacuum tubes and loud speaking reproducer.

The invention will be more clearly understood by reference to the following specification and accompanying drawings, in which:

Figure 1 is a wiring diagram of the amplifier and electrical reproducer arranged for connection to a source of alternating current power supply with means for eliminating the hum of the alternating current power supply, and Fig. 2 is a modification showing a wiring diagram of the apparatus illustrating means in the thermionic vacuum tube circuits for eliminating the hum of the alternating current power supply.

It will be understood that the principles of our invention may be embodied in various forms and that details are not material. The present embodiment of the invention, therefore, is to be considered as merely indicative. The form illustrated in the drawing and hereinafter described in detail has been found to be one of the practical embodiments and capable of efficient operation and practical in construction.

The apparatus of the present invention comprises a readily portable unit having terminals for the connection of the equipment to any source of electrical variations required to be amplified and electrically reproduced at increased amplitude through a loud speaking telephone. The unit includes a plurality of thermionic vacuum tubes connected in circuit for audio frequency amplification. The loud speaking telephone may be of the type employing a coil armature and electromagnetic field coil. A pair of terminals is provided for the connection of the unit to a source of alternating current power supply as, for example, the usual 110 volt 60 cycle supply. The power is connected to the primary winding of a transformer having proportionate windings thereon for energizing the various circuits of the unit. The filaments of the amplifier tubes are energized from one of these windings. Rectifiers are employed in the unit whereby energy derived from other windings is rectified and supplied as a source of plate circuit potential for the vacuum tube amplifier and as a supply for energizing the field of the loud speaking reproducer. The rectifiers are preferably of the two electrode valve construction and have their filaments energized from other windings on the transformer. Means are provided for biasing the grids of the vacuum tubes comprising the amplifier. Means are also included in the circuits of the amplifier for eliminating the hum from the alternating current power supply and means are included in the equipment for smoothing out the rectified energy supplied to the plate circuits of the amplifier.

Referring to the circuit diagram shown in Figure 1, reference characters 1 and 2 indicate the input terminals of the audio frequency amplifier and lead to the primary winding of the audio frequency transformer 4. The secondary terminals of transformer 4 are connected to the grid of vacuum tube 5 and to the slider of the stabilizing rheostat 11 through battery 12 respectively. The battery 12 connected in series with the slider of rheostat 11 has a potential of about 10 volts so connected that a negative voltage is impressed on the grid of tube 5. The

purpose of stabilizer 11 is to keep the normal voltage of the grid at a steady value with respect to the filament and eliminate the hum of the alternating current supply while the negative voltage from battery 12 holds the grid at its best potential for amplifying purposes. As this battery furnishes grid voltage only, the power drawn from it is negligible. It is therefore of the small flash light battery type and will continue effective for a period equivalent to its normal shelf life. The primary winding of audio frequency transformer 6 is connected in the output or plate circuit of vacuum tube 5. The secondary of audio frequency transformer 6 is connected to the grid of tube 7 and to stabilizer 11, with series grid battery 12, functioning the same as in the first stage.

In the output or plate circuit of tube 7 the primary of the telephone transformer 8 is connected, which has a one to one ratio of winding. This transformer also serves to reduce the hum of the alternating current supply. The secondary of this transformer may be connected to any type of loud speaking reproducer. In the present instance a loud speaker having a field winding may be employed and this secondary winding may lead to the primary winding of a stepdown transformer employed with the loud speaker, the secondary winding of which leads to the armature coil 9 as is usual in this instrument.

29 is a transformer having a primary winding 24 to which the 110 volt, 60 cycle A. C. power is applied at terminals 27 and 28. Winding 22 supplies the filament voltage for the rectifier tube 18, rheostat 19 being in series to regulate its brilliancy. Winding 21 supplies high voltage for the plates of the amplifier tubes 5 and 7, said high voltage being rectified by tube 18 and smoothed out by condenser 16 which is about 4 microfarads capacity, and a choke coil 17. This provides a high voltage direct current which is suitable for the plates of the amplifying tubes.

Winding 20 provides the proper voltage for lighting the filaments of the amplifier tubes 5 and 7, and their brilliancy is controlled by rheostat 15.

Reference numeral 10 represents the electro-magnetic field coil of the loud speaker and is excited by low voltage direct current supplied by the tungar rectifier tube 14. The filament of this tube is lighted from winding 25 of transformer 29 and winding 26 supplies the proper voltage which is rectified by tungar tube 14 and applied to the field winding 10.

In spite of the fact that the sole source of power for this circuit is from the 60 cycle alternating current source, there is practically no resultant hum in the loud speaking telephone due to the reactance offered by the winding 10 and the cooperative effect of this winding with the output circuit of the amplifier system. That is to say the inductance of the field coil 10 is selected of such value and the power amplifier is so connected with the winding 9 that pulsations in the field winding are effectively opposite in phase to the phase of the pulsations in the output circuit of the amplifier so that there is a tendency for the disturbing currents to be neutralized as a result of which the armature remains stationary so far as the effects of disturbing current components are concerned.

A modified form of this circuit is shown in Fig. 2, wherein there is a condenser 36 of about .02 microfarads capacity shunted by a leak resistance of about 2 megohms, in series with the slider of the stabilizer 30 in the grid circuit of tube 5. This condenser serves to keep the normal voltage of the grid at a suitable value for amplifying audio frequency energy impressed at terminals 1 and 2, at the same time acting as a partial block to any existing low frequency hum. The leak resistance prevents the grid from becoming supercharged.

In the plate circuit of tube 5, in series with the primary of the audio frequency transformer 6, is a condenser 32 of about .02 microfarads shunted by a resistance of approximately 80,000 ohms. This condenser serves to partially block the 60 cycle hum, but allows the higher frequencies to pass through. The shunt resistance allows the direct current plate voltage to reach the plate around the condenser, but serves as a block to the low frequency hum.

In series with the secondary of the audio frequency transformer 6 in the grid circuit of tube 7 is a .02 microfarad condenser 31 shunted by a 2 megohm resistance. This condenser and leak 31 function the same as condenser and leak 36 in eliminating any low frequency hum.

A .02 microfarad condenser shunted by an 80,000 ohm resistance 34 is in series with the plate circuit of tube 7 and functions in the same manner as condenser and resistance 32 to eliminate any residual low frequency hum.

Condenser 35 is about .005 microfarads capacity and is in series with the secondary of the telephone transformer 8. It also serves as a partial block to any low frequency hum which may be present. The transformer 29 is arranged with terminals 27 and 28 for connection to the usual source of 110 volt A. C. residence lighting power and includes the several proportionate windings for supplying energy to the circuits of the unit as described in Fig. 1.

In the operation of the apparatus terminals 1 and 2 are connected to any source of audio frequency electrical energy to be am-

plified and reproduced. The terminals 1 and 2 may be connected to the output circuit of a detector tube in a radio receiver. Terminals 27 and 28 are connected through a flexible cord plug with the residence lighting circuit. Rheostat 15 is regulated to secure the proper filament temperature of the amplifier tubes. Rheostat 19 is regulated to secure the proper plate potential for the amplifying tubes. The sliders of rheostats 11 and 30 are adjusted to an electrical midpoint in the resistance, at which point the voltage impressed on the grid of tubes 5 and 7 from the A. C. supply is steady or of very small value. By this adjustment the hum is eliminated from the reproducer circuits. The audio frequency energy variations supplied to terminals 1 and 2 are reproduced at great volume of sound by the reproducer comprising windings 9 and 10.

It will be understood that we are not limited to the use of a reproducer employing a field winding but that any type of reproducer may be employed. The disturbing pulsations which may be present in the winding 9 are of opposite phase by virtue of the phase shifting circuit 8—9, than the phase of disturbing pulsations or currents in the winding 10. The mutual effect therefore is nil as the pulsations tend to be neutralized and have no effect upon the armature.

The entire equipment, including the reproducing horn of the loud speaker, is adapted for mounting within a readily portable cabinet.

Having thus described our invention what we claim and desire to secure by Letters Patent of the United States is as follows:

1. In an apparatus for the reproduction of sound, the combination of a thermionic vacuum tube amplifier circuit, a power source of alternating current, means for rectifying said current, means for supplying the rectified current to said vacuum tube amplifier circuit, a loud speaker reproduced of the electrodynamic type connected to said amplifier, and means for supplying rectified current to said reproducer.

2. In an apparatus for the reproduction of sound, a thermionic vacuum tube amplifier, an input circuit, an output circuit, a power source of alternating current, means for rectifying said current, a loud speaker reproducer connected in said output circuit and comprising an armature winding and a field winding and circuits for supplying said rectified current to said output circuit and to said field winding, said windings being connected in such relation that disturbing current effects in said loud speaker reproducer are substantially eliminated.

3. In an apparatus for the reproduction of sound, a thermionic vacuum tube amplifier, an input circuit and an output circuit, a loud speaker reproducer comprising an armature winding and a field winding, connections between said output circuit and said armature winding, a power source of alternating current, means for rectifying said current and supplying said rectified current to said output circuit and to said field winding, said windings being so connected with said means as to substantially oppose the effect of disturbing currents in said loud speaker reproducer.

4. In an apparatus for the reproduction of sound, a thermionic vacuum tube amplifier, an input circuit, an output circuit, a power source of alternating current, a plurality of means for rectifying said current, filters for smoothing out the rectified current and supplying said rectified current to said output circuit, means in said output circuit for reproducing the signal energy and connections whereby one of said rectifiers supplies energy to said reproducing means, said reproducing means being arranged to substantially neutralize disturbing currents.

5. In an apparatus for the reproduction of sound, a thermionic vacuum tube amplifier, an input circuit, and output circuit, a loud speaker reproducer comprising an armature winding and a field winding, connections between said output circuit and said armature winding, a power source of alternating current, means for rectifying said current, means for smoothing out the rectified current and supplying said current to said output circuit and said field winding with the alternating current components thereof in phase opposition whereby the effect of said alternating current components on said loud speaker reproducer are substantially eliminated.

6. In an apparatus for the reproduction of sound, a thermionic vacuum tube amplifier, an input circuit, an output circuit, a power source of alternating current, means for rectifying said current, filters for reducing the hum of the rectified current, and supplying said rectified current to said output circuit, a loud speaker in said output circuit for reproducing the signal energy and means connected to said loud speaker and associated with said power source for opposing the residual hum of the rectified current.

7. A sound reproducing apparatus comprising in combination an electron tube amplification system including a filament heating circuit, an output circuit, a loud speaker sound reproducer having a pair of windings, one of said windings connected with said output circuit, and connected to a source of alternating current, a device for rectifying a portion of said current for supplying the rectified current to the other of said aforementioned windings, means for deriving

power from said source for energizing said filament heating circuit and said output circuit, said first mentioned winding being connected with said output circuit in such manner that interfering current pulsations occur therein in substantially opposite phase with respect to interfering current pulsations in said second winding for neutralizing the effects of said interfering current pulsations upon said sound reproducing apparatus.

8. An electromagnetic sound reproducing system comprising in combination a power amplifier having circuits arranged to be excited from a power source of alternating current, a loud speaker reproducer including a circuit energized from said power source and a circuit connected with said power amplifier, said last mentioned circuit including a condenser and a transformer having primary and secondary windings with the primary winding connected with said power amplifier and said secondary winding connected with said reproducer and arranged in such manner that alternating current components existent in said circuits occur in substantially opposite phase whereby the effects of said alternating current components on said loud speaker reproducer are substantially neutralized.

9. In a sound reproducing apparatus the combination of an amplifier, a loud speaker having armature and field winding with said armature winding connected to the output of said amplifier, an alterating current supply source, means for deriving power from said source for energizing the circuits of said amplifier, filter circuits for reducing the hum of said alternating current in said apparatus and means for supplying power from said source to said field winding in such manner that the residual hum in said field winding will oppose the residual hum in said armature winding for eliminating the hum of said alternating current in said apparatus.

FRANCIS W. DUNMORE.
PERCIVAL D. LOWELL.

Certificate of Correction.

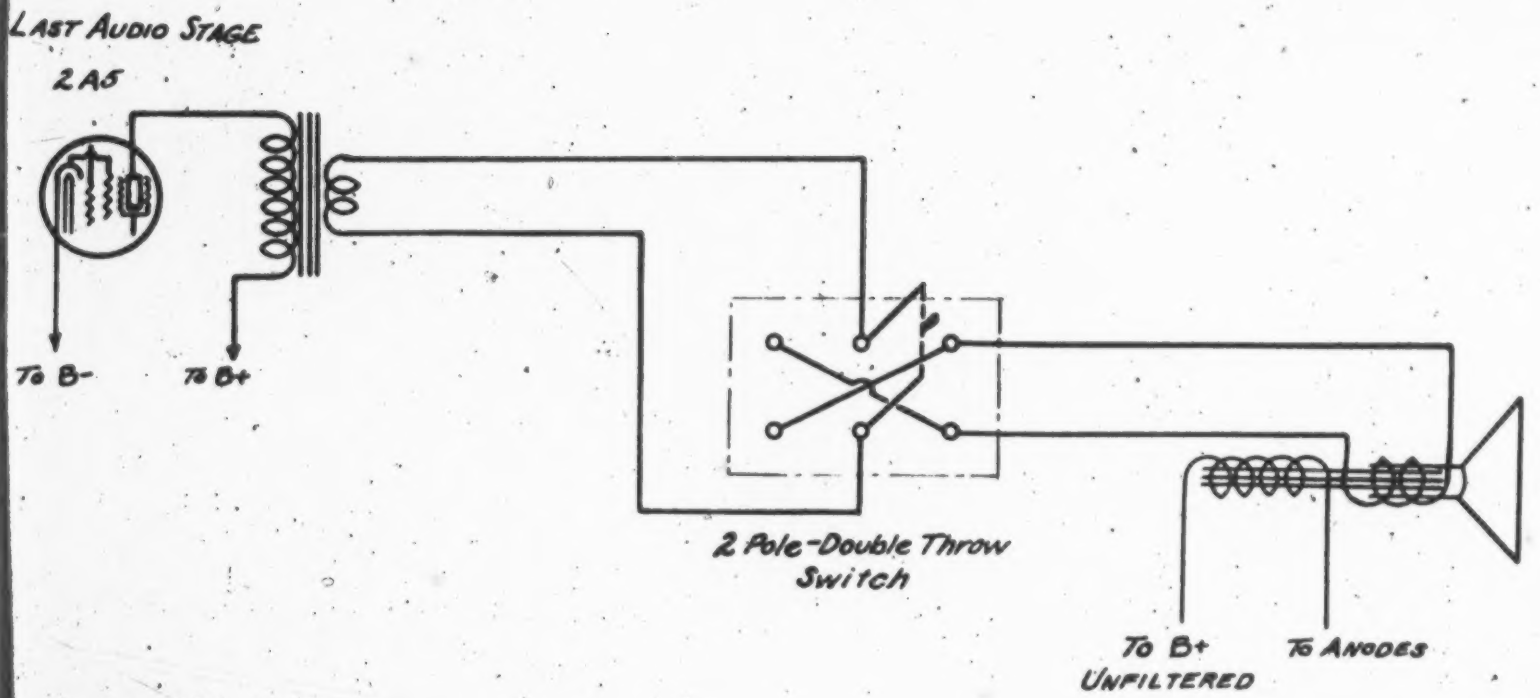
It is hereby certified that in Letters Patent No. 1,606,212, granted November 9, 1926, upon the application of Francis W. Dunmore and Percival D. Lowell, of Washington, District of Columbia, for an improvement in "Power Amplifiers," errors appear in the printed specification requiring correction as follows: Page 3, line 46, claim 1, for the word "reproduced" read *reproducer*, and line 93, claim 5, for the word "and" read *an;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 14th day of December, A. D. 1926.

[SEAL.]

M. J. MOORE,
Acting Commissioner of Patents.

STEWART-WARNER MODEL 109 - ARRANGED FOR TEST AT VOICE COIL OF REPRODUCER



PLAINTIFFS' EXHIBIT No. 92.
(Wiring diagram of test on Defendants' Set SW 109)

[fol. 381] PLAINTIFFS' EXHIBIT No. 93

(Stipulation covering sale of sets by defendants and correctness of wiring diagrams including sets S. W. 104, 105, 106, 108, and 109.)

UNITED STATES DISTRICT COURT, DISTRICT OF MARYLAND

Equity No. 2193

PERCIVAL D. LOWELL, FRANCIS W. DUNMORE and DUBILIER CONDENSER CORPORATION, Plaintiffs,

vs.

A. G. TRIPLETT, R. M. TRIPLETT, A. NELSON, C. M. TRIPLETT, JR., and THE BALTIMORE GASLIGHT COMPANY, Defendants

STIPULATION

It is stipulated that within six years prior to the filing of the bill of complaint herein and both prior to and subsequent to August 6, 1933, the defendant has sold radio broadcast receiving sets embodying the construction described and illustrated in the attached diagrams, descriptions and publications as follows:

Stewart Warner A. C. Model 104 shown in the printed sheet entitled "Circuit Data for Stewart Warner A. C. Series R-104"; blueprint marked I. N. 405; printed pamphlet entitled "Instructions for Stewart Warner Series 40 Radio Receivers".

Stewart Warner Model 105 shown in the printed leaflet entitled "Chassis Model 105 Receiver Models 50 to 59"; blue print marked "I. N. 407" and printed pamphlet entitled "Instructions for Stewart Warner Series 50 Radio Receivers".

Stewart Warner Model 106 shown in printed leaflet marked "Circuit Data for Stewart Warner A. C. Series [fol. 382] R-106"; blueprint I. N. 404; blueprint marked I. N. 422; printed leaflet entitled "Stewart Warner Series 60".

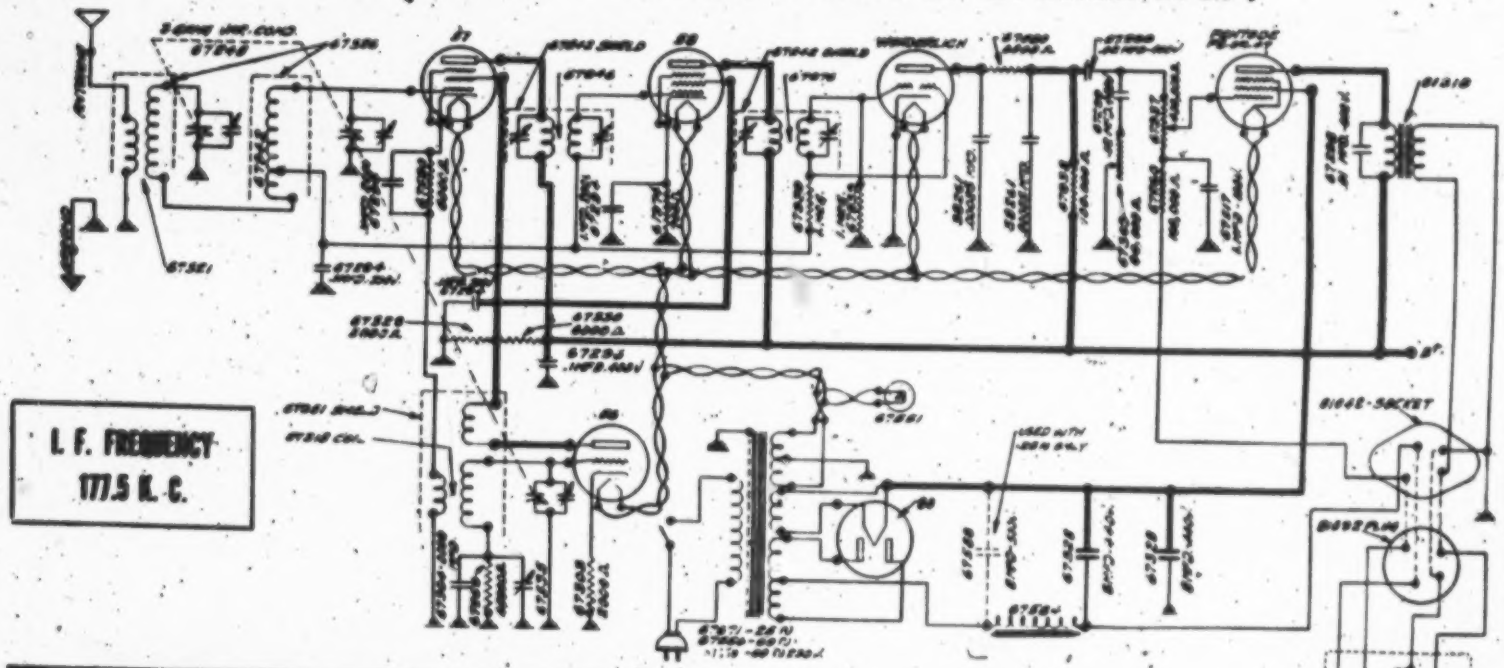
Stewart Warner Model 108 shown in printed leaflet entitled "Circuit Data for Stewart Warner Chassis Series 108 and 108.X"; blueprint I. N. 426; printed leaflets entitled "Stewart Warner Chassis Model 108 Instructions", "Stewart Warner Chassis Model 108 Instructions".

Stewart Warner Model 109 shown in printed leaflet entialed "Chassis Model 109, Receiver Models 1090 to 1099"; blueprint I. N. 427; leaflet entitled "Stewart Warner Chassis Model 109 Instructions".

C. V. Edwards, Counsel for Plaintiffs. Samuel E. Darby, Jr., Counsel for Defendants.

Dated June 5, 1934.

Circuit Data for Stewart-Warner A. C. Series R-104



LINE VOLTAGE 115 **VOLTAGE TABLE** VOLUME CONTROL FULL ON

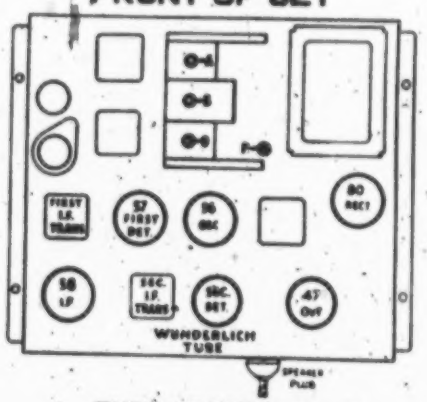
Type of Tube	Tube Circuit	Filament Voltage	Plate Voltage	Screen Grid Voltage	Bias Voltage
'57	1st Det.	2.57	256	100	3.5
'56	Osc.	2.57	100		7.8
'56	I. F.	2.56	256	100	3.9
Wunderlich	2nd Det.	2.56	37		
P. Z. or '47	Output	2.56	239	256	15.75
'80	Rect.	4.9			

All D. C. voltages measured with respect to ground, using high resistance voltmeter of 1000 ohms per volt. Readings will vary, depending upon voltage range of meter, being higher for higher range instruments. This variation is most marked for second detector plate voltages.

This reading obtained between ground and that prong of speaker socket situated furthest from other three. Direct reading from grid to ground or reading taken with a set tester will show about 3 volts because of high resistance in grid circuit.

Form 3023 Printed in U. S. A.

FRONT OF SET



TUBE LOCATIONS

PHILCO'S SERVICE ED. 93, Sheet 2.
Circuit Data for Stewart-Warner A.C. Series R-104

691
383—384

2996

SERVICE DATA ON MODEL 104, CHASSIS

CIRCUIT DESCRIPTION OF 104 CHASSIS

The Model 104 Stewart-Warner Radio Chassis makes use of a six-tube superheterodyne circuit embodying automatic volume control (A.V.C.) thru the action of its Wunderlich-type detector tube. An incoming signal is tuned first by a pre-selector circuit to increase selectivity and reduce image frequency interference and then fed into a tuned first detector stage, where it beats with the output of a local oscillator to produce a 177.5 K. C. intermediate frequency signal. This odd frequency is chosen to reduce further any image frequency interference. The I.F. signal is amplified in an exceptionally high gain stage and then fed into the Wunderlich tube which performs the triple functions of detection, amplification, and automatic volume control. As a result of the A.V.C. action of this tube a voltage varying in value in direct relationship to the strength of the incoming signal, appears across the 1 megohm resistor connected between one of its grids and ground. This resistor is also in the grid return circuit of both the first detector and I.F. tubes, so that their biases increase in direct relationship to the strength of the incoming signal. This action results in an automatic control of sensitivity.

The plate circuit audio output of the detector tube is impressed across the 400,000 ohm variable resistor in the grid circuit of the pentode tube. Volume is controlled by using this variable resistor as a voltage divider to feed any desired audio voltage from zero to the maximum available across the pentode grid circuit.

ALIGNING THE 104 CHASSIS

Alignment can be carried out intelligently only if the service man knows the general layout of the set, and how each circuit is affected during the process of alignment. The simplified top view of the chassis appearing on the other side of this sheet gives the layout of the receiver and indicates the names and locations of the various aligning adjustments. The following brief discussion of what actually happens during alignment should be carefully read, using the sketch as a basis before commencing the actual work.

LOCATION AND FUNCTION OF ALIGNING ADJUSTMENTS

The incoming signal is tuned first by the pre-selector "A" stage and then fed into the first detector "B" circuit, where it is tuned again to improve selectivity. These circuits are brought into exact alignment by the two trimmer condensers "A" and "B," pointed out in the attached sketch. The tuned oscillator circuit is so designed that it tunes to a frequency exactly 177.5 K.C. higher than the incoming signal. This circuit is kept in exact step by means of two adjustments, the oscillator condenser trimmer "O," and the padding condenser "P," which can be reached thru a small hole in the chassis base just in front of the "O" condenser.

THE "O" TRIMMER IS MAINLY EFFECTIVE AT THE HIGH FREQUENCY END OF THE DIAL, AND THE PADDING CONDENSER "P" AT THE LOW FREQUENCY END. The alignment routine which will be outlined takes this into consideration.

The two intermediate frequency (I. F.) transformers are of the tuned input,—tuned output type and each winding is tuned by a separate trimmer condenser, making a total of four additional adjustments. The first I. F. transformer is in the steel shield at the right side of the set, while the second I. F. transformer is at the rear of the chassis. The I. F. trimmer adjusting screws can easily be reached thru two small holes at the base of each shield, the primary circuit adjustment in each case being at the left and the secondary adjustment at the right.

PRELIMINARY STEPS IN ALIGNING

In aligning the Model 101 it is essential to use a high grade oscillator and sensitive output meter. The R. F. signal fed into the receiver must be very weak or it will cause the A. V. C. circuit to function, making correct alignment impossible. The output meter must be sufficiently sensitive to give a satisfactory reading with this low signal.

Before starting the alignment procedure see that the volume control is full on, and the output meter connected either between the pentode plate and ground thru a .25 mfd condenser or across the voice coil, depending upon its sensitivity.

ALIGNING PROCEDURE

With this preliminary discussion clearly in mind, the actual alignment can be started. The following step-by-step routine should be followed for satisfactory results.

1. Remove the grid clip leading from the variable condenser to the cap of the first detector tube.
2. Set up the oscillator, and tune it to exactly 177.5 K.C. (This frequency can be accurately determined by tuning in a station at either 710 or 1420 K.C. and beating the 4th or 8th harmonic of the oscillator 177.5 K.C. signal against it. To be sure that you have the harmonic of the 177.5 K.C. signal, instead of some other frequency, tune in the other 177.5 harmonics on the broadcast dial. These should come in 177.5 K.C. on either side of the original setting. Do not use the oscillator calibration curve to determine this intermediate frequency.) Connect the oscillator output between the grid cap and grid clip of the first detector tube.
3. Adjust the oscillator output to give about one-half full scale deflection of the output meter.

Adjusting the I. F. Circuits

1. Adjust all four I. F. trimmer condensers, in each case tuning carefully to make sure that maximum deflection is obtained on the output meter.

IT IS VERY IMPORTANT THAT ABSOLUTELY NO INWARD PRESSURE BE APPLIED TO THE ALIGNMENT TOOL, OR THE CONDENSER MAY SPRING BACK TO A DIFFERENT SETTING AS SOON AS THE TOOL IS REMOVED.

2. Go back and repeat all four adjustments since the adjustment of each I. F. trimmer affects the others to a certain extent, thus necessitating readjustment.

Adjusting R. F. and Oscillator Circuits

1. Replace the grid cap on the first detector tube.
2. Twist the aerial and ground wires of the set together to reduce noise pick-up. Connect the aerial wire to the output of the oscillator and ground both set and oscillator. Adjust the oscillator frequency to 1400 K.C. and carefully tune the receiver to give maximum output. Adjust the oscillator output to produce about one-half full scale deflection of the output meter.
3. Carefully tune the "A" trimmer till the output meter reading reaches a maximum.
4. Note the wire leading from the grid cap of the 57 first detector tube (see tube layout diagram on the reverse side of this sheet), to the tuning condenser. The section of the condenser gang to which this lead is soldered is the "B" section. Altho this "B" section is shown as the center condenser section on the diagram, some sets were manufactured with the "B" section in the rear.

Retune the set and adjust the "B" trimmer for maximum output. The third, or "O" trimmer should not be touched unless the set is badly out of calibration at the high frequency end of the dial.

5. Set the oscillator at 600 K.C. and tune the set carefully to this frequency.
6. Adjust the oscillator padding condenser "P" for maximum output, RETUNING THE SET AFTER EACH CHANGE IN ADJUSTMENT. This is important.
7. Turn back the oscillator to 1400 K.C., tune the set to the same frequency, and very carefully readjust the "A" and "B" trimmer condensers to produce maximum output.

The receiver should now be perfectly aligned.

104 PARTS LIST

Part No.	Description	List Price
38261	.00025 mfd. condenser	$0.35
67210	Speaker diaphragm and voice coil assembly	1.85
67212	I.F. coil shield	.25
67218	Main tuning condenser	3.50
67239	15000 ohm, ½ watt resistor	.25
67260	100,000 ohm, ½ watt resistor	.25
67291	.1 mfd. 200 volt condenser	.30
67296	.1 mfd. 400 volt condenser	.40
67298	.01 mfd. 600 volt condenser	.30
67299	.02 mfd. 400 volt condenser	.30
67303	2000 ohm, ½ watt resistor	.25
67304	.0009 mfd. padding condenser	.30
67309	60,000 ohm tone control	1.50
67318	Oscillator tuning coil	1.25
67321	"A" tuning coil	1.00
67326	R.F. coil shield	.50
67328	8 mfd. 150 volt electrolytic condenser	1.75
67329	3000 ohm vitreous resistor	.30
67330	6000 ohm vitreous resistor	.30
67517	1. mfd. 400 volt condenser	.75
67335	Oscillator pad trimmer condenser	.45
67351	2.5 volt pilot light	.25
67356	175 volt 60 cycle power transformer	3.50
67380	6000 ohm, ½ watt resistor	.25
67381	Speaker field coil	3.50
67384	Filter choke coil	2.00
67388	8 mfd. 300 volt electrolytic condenser	1.85
67671	115 volt 25 cycle power transformer	8.00
67937	400,000 ohm volume control	.95
67938	100,000 ohm, 1 watt resistor	.25
67939	1 megohm, ½ watt resistor	.25
67942	"B" tuning coil	.75

Part No.	Description	List Price
67944	1st I.F. transformer	2.00
67946	67181 coil only	.75
	67336 trimmer only	.65
67951	Oscillator coil shield	.75
67974	700 ohm, 1 watt resistor	.25
67976	2nd I.F. transformer	2.00
	67181 coil only	.75
	67336 trimmer only	.65
81042	Speaker socket	.20
81092	81092 Speaker plug only	.20
	67972 Cable and plug	.60
	67971 Cable only	.40
81139	230 volt 60 cycle power transformer	10.00

PARTS NOT SHOWN ON DIAGRAM

67332	Rubber dial drive bushing	.02
67953	Escutcheon plate	.50
81112	Volume or tone control knob	.25
81113	Tuning knob	.25

DEC 12 1933

IN-405

'PLAINTIFFS' EXHIBIT No. 93, Sheet 4.

REVISIONS

NO.	DATE	BY

5 GANG VARI. COND.

ANTENNA

GROUND

'37

'58

'58

WUNDERLICH

PENTODE PZ '47

SPEAKER SOCKET

B+

C.S.I. LAMP 67351

POWER SUPPLY

SWITCH

FOR E

POWER SUPPLY.

SWITCH

FOR A & B

SPEAKER PLUG

SPEAKER CABLE.

ELECTRO DYNAMIC SPEAKER.

NOTE.- THIS CIRCUIT IS FOR MODELS R-104 A, B & E ON TA.2476

(1)	67298	.1 MFD. 200 V.
	67294	1 MFD 200 V.
(2)	67294	.1 MFD 200 V.
(4)	67294	.1 MFD. 200 V
(5)	67296	1 MFD. 400 V.
(6)	67298	.01 MFD. 400 V.
(7)	67299	.05 MFD 400 V.
(9)	67299	.02 MFD 400 V.
(10)	67513	1. MFD. 100 V.
(11)	67328	8 MFD 440 V.
(12)	67324	8 MFD 440 V.
(13)		... MFD ... V.
(14) (15)	67248	TUNING CONDENSER.
(16)	67304	.0009 MFD.
(17)	67336	TRIMMER COND.
(18)	58261	.00025 MFD.
(19)	58261	.00025 MFD.
		OR 41157

(20)	67580	6000 ohm ½ WATT
(21)	67303	2000 ohm ½ WATT
(22)	67981	400 ohm 1 WATT.
(23)	67330	6000 ohm
(24)	67329	5000 ohm
(25)	67334	1 MEG. ½ WATT.
(26)	67339	1 MEG. ½ WATT.
(27)	67338	100 000 ohm 1 WATT.
(28)	67340	100 000 ohm ½ WATT.
(29)	67309	60 000 ohm TONE CONTROL
(30)	67337	400000 ohm VOLUME CONTROL
(31)	67259	45 000 ohm ¼ WATT.
(32)	67 [illegible]	6000 ohm ½ WATT

(41)	67321	A COIL (PRE-SELECTOR)
(42)	6794	B COIL (1ST DETECTOR)
(43)	.1318	OSCILLATOR COIL
(44)	67946	1ST I.F. TRANS ASSEM.
(45)	67976	2ND I.F. TRANS ASSEM.
(46)	67654	OUTPUT TRANS.
(46)	67384	POWER SUPPLY FILTER CHOKE.
(47)	67556	POWER TRANS. ASSEM. 60 [illegible] 115
	67671	" " " " 115
	[illegible]	" " " " 200V, 385 I. 5 EFOV.

100V. BLK. YEL. GRN. BLK. RED. YEL. RED. PRI. #1 PRI. #2 GRN. RED.

230V. BLK. YEL. GRN. BLK. RED. YEL. RED. PRI. #1 PRI. #2 GRN. RED.

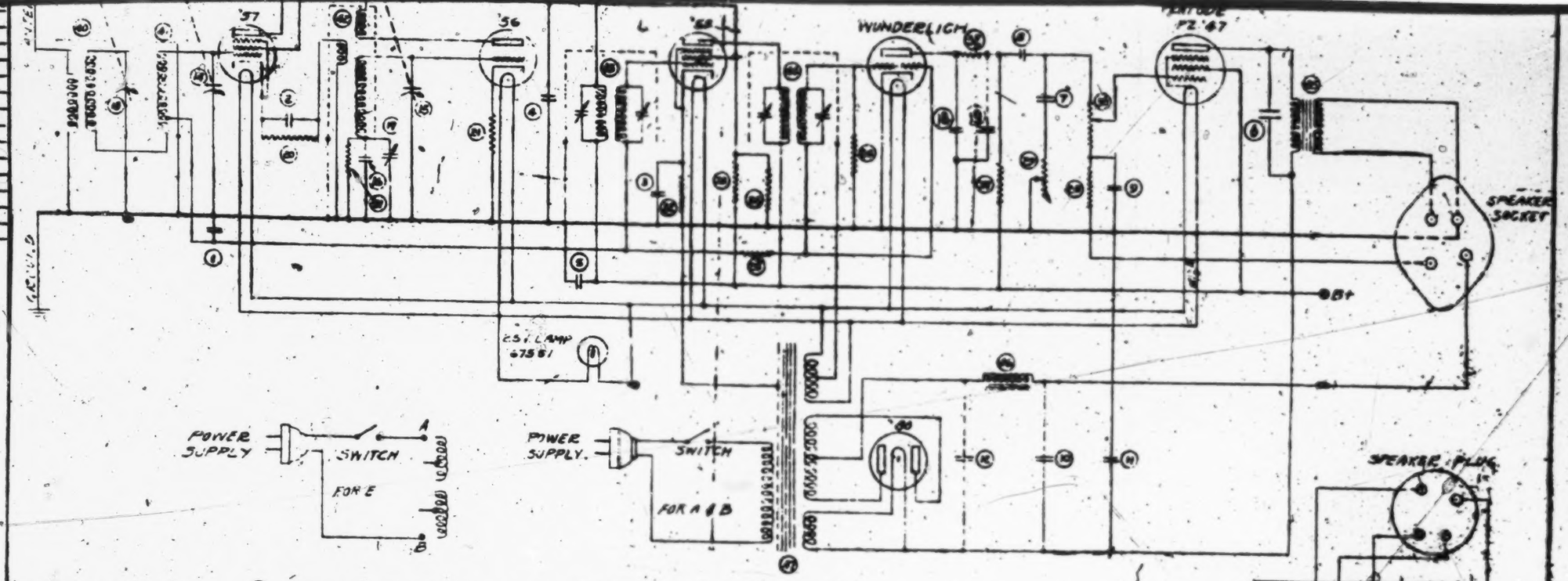
225V. BLK. YEL. GRN. BLK. RED. YEL. RED. PRI. #1 PRI. #2 GRN. RED.

250V. BLK. YEL. GRN. BLK. RED. YEL. RED. PRI. #1 PRI. #2 GRN. RED.

POWER TRANS PRIMARY CONNECTIONS (CIRCUIT FOR 10E & MODEL)

CAUTION

CIRCUIT DIAGRAM



(1) 67294 .1 MFD. 200 V.
67294 .1 MFD. 200 V.
67294 .1 MFD. 200 V.
67294 .1 MFD. 200 V.
67296 1 MFD. 400 V.
67298 .01 MFD. 600 V.
67299 .05 MFD. 400 V.
67299 .02 MFD. 400 V.
67513 1. MFD. 100 V.
67528 .8 MFD. 440 V.
67324 8 MFD. 440 V.
[illegible] V.

(14) [illegible] ABLE
(15) 67248 TUNING CONDENSER.

(16) 67304 .0009 MFD.
(17) 67535 TRIMMER COND.
(18) 38261 .00025 MFD.
(19) 38261 .00025 MFD.
OR 81157

(20) 67580 6000 Ω ½ WATT
(21) 67303 2000 Ω ½ WATT
(22) 67981 400 Ω 1 WATT
(23) 67330 6000 Ω
(24) 67329 5000 Ω
(25) 67334 1 MEG. ½ WATT.
(26) 67939 1 MEG. ½ WATT.
(27) 67338 100 000 Ω 1 WATT.
(28) 67330 100 000 Ω ½ WATT.
(29) 67309 60 CYCLE TONE CONTROL
(30) 67337 400000 Ω VOLUME CONTROL
(31) 67259 45 000 Ω ¼ WATT.
(32) 67 [illegible] 6000 Ω ½ WATT

(40) 67321 H COIL PRE-SELECTOR)
(41) 67[illegible] H COIL (1ST DETECTOR)
(42) 1818 O OSCILLATOR COIL
(43) 67946 1ST I.F. TRANS. ASSEM.
(44) 67976 2ND I.F. TRANS ASSEM.
(45) 67654 OUTPUT TRANS.
(46) 67384 POWER SUPPLY FILTER CHOKE.
(47) 67556 POWER TRANS. ASSEM. 60 [illegible] 115
67671 " " " " 115
G " " " " 60 [illegible] 200V., 225V., 250V.

POWER TRANS PRIMARY CONNECTIONS
(CIRCUIT FOR 104 E MODEL)

CAUTION
[illegible]
DO NOT SCALE DRAWING, USE DIMENSIONS.
ALL DIMENSIONS GIVEN IN INCHES.

SIZE OF SHEET "B"

CIRCUIT DIAGRAM
DATE 5-9-52
DRAWN BY G.W.H.
TRACED BY L.W.H.
CHECKED BY
APPROVED BY
IN-405

STEWART-WARNER CORPORATION, CHICAGO, U. S. A.

PLAINTIFFS' EXHIBIT No. 93, Sheet 5, 389- 390

INSTRUCTIONS

for

STEWART-WARNER SERIES 40 RADIO RECEIVERS

(Chassis 104-A, B and E.)

IMPORTANT!

YOUR Stewart-Warner Radio Receiver is not guaranteed unless you have filled in and mailed the warranty card accompanying each set within ten days after the purchase of the set. Be sure and ask your dealer for this card if it does not accompany the set.

STEWART-WARNER CORPORATION

CHICAGO, ILL., U. S. A.

INSTRUCTIONS

for

STEWART-WARNER SERIES 40 RADIO RECEIVERS

(CHASSIS 104-A, B. and E)

FACTS YOU SHOULD KNOW CONCERNING RADIO RECEPTION

Your Stewart-Warner radio receiver with its extreme sensitivity and its marvelous realism of tone can be a source of untold enjoyment to you. It opens up a vast field of entertainment and genuine knowledge that would otherwise be beyond your reach. Music by the world's greatest artists, entertainment of the most varied type, word pictures of interesting events of history as they are being enacted while you listen, talks by our most famous men, embracing the entire field of human endeavor—in fact, there are no limits to the entertainment your radio can provide.

However, to avail yourself of these benefits in the fullest measure, it is necessary that you be familiar with a few important facts governing radio reception.

The radio waves that actuate your receiver are so intangible in form and so infinitesimal in power, yet travel at such terrific speeds that it is almost impossible for the human mind to conceive of them. They cannot be felt, seen, heard or tasted; they travel at a speed which would carry them seven and one-half times around the world in a second, they are measured in fractions of a fly power, if such a unit can be said to exist, and yet so sensitive is your Stewart-Warner radio receiver that it reproduces their minutest variations in the form of sound with perfect accuracy.

Under certain conditions the forces of nature tend to modify and restrict these radio waves after they leave the broadcast station, thus affecting the reproduction of the program. At times we have the phenomenon known as static; we have periods of maximum and minimum reception, fading of signals, and other peculiarities of radio reception for which the radio receiver is not responsible and cannot entirely compensate. We list a few of these to give you some idea of what to expect from your Stewart-Warner radio receiver.

DISTANT STATIONS

Reception from distant stations depends on a number of factors, such as local conditions, season of the year, time of day, the aerial used, and the power of the broadcasting station. As a general rule, distant reception is at its best during the winter months. Nighttime reception is always far better than daytime reception. On an occasional exceptionally favorable night some stations may come rolling in with local volume and

PLAINTIFF'S EXHIBIT NO. 93, Sheet 6.
391-392
69

...e picked up again. On other nights distant stations from one direction ... unusually loud, and closer, more powerful, stations in other directions be ... Quite often there may seem to be a perfect blanket that kills all distant ... There is no telling beforehand how reception may be affected—actually it ...y minute.

...ception of distant stations, particularly in the summer months, is accom- ...more or less crackling or frying noises known as static. Although such noise ...e, not at all noticeable during the reception of a local broadcast program, it ...e quite troublesome on distant stations. Fortunately static is very largely ...to the higher notes so that if the tone control of the Stewart-Warner Radio ...s turned toward the right to produce a deeper tone, the noise will be greatly ... that the static-distorted program can be enjoyed without excessive inter- ...This is an important point to bear in mind.

FADING

...waves coming in from distant stations will occasionally decrease in strength ...ss gradually until they are lost entirely, then come in again a few seconds ...full volume. This peculiarity of radio reception, known as "fading," is ... the reflection and partial absorption of radio waves by clouds, ionization ...osphere by the sun's rays, and other similar phenomena.

... the automatic volume control action of the receiver will neutralize this varia- ...letely and maintain a uniform volume, the only indication of fading of the ...ave being a periodic increase and decrease in the amount of static noises, ...onally a variation in tone quality, as the station wave fades out and comes in ...owever, in extreme cases, where fading is so bad that nothing can be done to ...condition at the receiver, the station may drop out of hearing entirely.

NOISES IN RECEPTION

...f the frying or crackling noises heard in a radio receiver when the volume ...well advanced are due to electrical discharges in the atmosphere (known as ...the operation of electrical machinery in the neighborhood of the set. Such ...e may be caused by any motor-driven device, such as a vacuum cleaner, ...tc., since the brushes of electric motors invariably cause a good deal of spark- ...may be a flashing electric sign, an X-ray or Violet ray machine, an oil burner, ...refrigerator, a neon sign, traffic control signal, or similar device. It may ...sed by loose contact of an electric bulb or iron in its socket. Electric heating ...to their use of an automatic make and break mechanism for regulating tem- ...re particularly prone to cause such trouble. Noise from these devices may ...ired even though the offending device be located in a neighbor's home at ...ce from the receiver.

...tural and man-made static are picked up by the aerial and ground systems, ...ily be shown by disconnecting both aerial and ground wires from the set, ...e the noise to disappear. If the noise interferes too greatly with reception ...ue to atmospheric disturbances as evidenced by reception in neighboring ...ough investigation of electrical machinery in the immediate neighborhood ...r the matter should be taken up with your radio dealer or the local electric ...any. A noise which continues when the aerial and ground are disconnected ...due to a defective tube or poor connection in the set.

...se picked up by the receiver, whether due to static or the operation of elec- ...tus or machinery, is made up very largely of the higher notes. If, there- ...e control of the receiver is turned to the right to produce deeper, more ...c, the effect of noise on radio reception is greatly minimized. This is an ...oint to bear in mind since the proper use of the tone control may mean all ...between enjoying a good program and listening to a succession of static

GENERAL

The location of the set itself has much to do with the quality of it music will provide. If it is placed in a large, bare room with no rugs, the sound waves proceeding from it will be reflected from the floors and walls and cause a noticeable loss of tone quality. Fortunately, the average living room has most of its large reflecting surfaces deadened or broken up by rugs, furniture and curtains, so that reception is normal.

The music coming from a radio set sounds much more pleasing to those in front, rather than to one side of the speaker and, therefore, the set should face into the room.

The volume at which a radio set is operated also affects its tone. Best results will be obtained when the volume of the radio receiver is about the same as the original music being broadcast. If the volume is reduced appreciably below this value the lower tones will tend to drop out, giving the music a higher, more reedy tone. On the other hand, if the set is turned full on the lower tones are over-emphasized.

Without a tone control it is impossible to compensate for this apparent lack of tone balance. However, this change in tone value may be easily rectified through correct use of the tone control. For low volume the tone control should be turned toward the right to help the bass notes, while for great volume, the tone control should be turned more toward the left to bring out the high notes and counteract the over emphasis of the bass so that the same realistic reproduction is maintained at all volume levels.

ANTENNA SYSTEM

Satisfactory radio reception is more dependent upon a proper antenna-ground installation than upon any other factor outside of the set itself.

It is the function of the antenna system to collect the energy radiated by the various broadcasting stations and carry this energy to the set. It therefore behooves the purchaser of a new radio set to exercise care in selecting and installing a suitable antenna system, so that he may derive a maximum of enjoyment and utility from his set.

CHOOSING THE AERIAL

The most satisfactory aerial for any particular installation will vary widely in different locations, depending largely upon local structural details and sources of interference. As a general rule an outside aerial is preferable to an inside one.

When erecting the aerial always bear in mind the fact that the volume and selectivity of a set are largely governed by the length of the antenna system.

As the length of the aerial is increased, the volume of distant stations will be increased, but the selectivity of the set will be decreased. At the same time reception will tend to become noisier, as a long aerial picks up more interference proportionately. **On the other hand, as the length of the antenna system is decreased, volume on distant stations will diminish but selectivity will increase.**

It must be remembered that in some cases a shorter antenna will bring in more stations than a very long one, as the increased selectivity permits reception without interference from nearby stations.

The most suitable aerial for use in large cities or congested radio districts where interference is a serious problem is one whose total length, including lead-in, is from thirty to sixty feet. In rural sections where no interference is obtained and volume is of extreme importance, a total length of 80 to 150 feet may be best.

PLAINTIFFS' EXHIBIT NO. 93, Sheet 7, 696 393-394

may never be picked up again.. On other nights distant stations from one direction only may be unusually loud, and closer, more powerful, stations in other directions be inaudible. Quite often there may seem to be a perfect blanket that kills all distant reception. There is no telling beforehand how reception may be affected—actually it changes every minute.

Radio reception of distant stations, particularly in the summer months, is accompanied by more or less crackling or frying noises known as static. Although such noise is, as a rule, not at all noticeable during the reception of a local broadcast program, it may prove quite troublesome on distant stations. Fortunately static is very largely restricted to the higher notes so that if the tone control of the Stewart-Warner Radio Receiver is turned toward the right to produce a deeper tone, the noise will be greatly reduced so that the static-distorted program can be enjoyed without excessive interference. This is an important point to bear in mind.

FADING

Radio waves coming in from distant stations will occasionally decrease in strength more or less gradually until they are lost entirely, then come in again a few seconds later with full volume. This peculiarity of radio reception, known as "fading," is caused by the reflection and partial absorption of radio waves by clouds, ionization of the atmosphere by the sun's rays, and other similar phenomena.

Usually the automatic volume control action of the receiver will neutralize this variation completely and maintain a uniform volume, the only indication of fading of the received wave being a periodic increase and decrease in the amount of static noises, and occasionally a variation in tone quality, as the station wave fades out and comes in again. However, in extreme cases, where fading is so bad that nothing can be done to rectify this condition at the receiver, the station may drop out of hearing entirely.

NOISES IN RECEPTION

Most of the frying or crackling noises heard in a radio receiver when the volume control is well advanced are due to electrical discharges in the atmosphere (known as static) or the operation of electrical machinery in the neighborhood of the set. Such interference may be caused by any motor-driven device, such as a vacuum cleaner, vibrator, etc., since the brushes of electric motors invariably cause a good deal of sparking, or it may be a flashing electric sign, an X-ray or Violet ray machine, an oil burner, an electric refrigerator, a neon sign, traffic control signal, or similar device. It may even be caused by loose contact of an electric bulb or iron in its socket. Electric heating pads, due to their use of an automatic make and break mechanism for regulating temperature are particularly prone to cause such trouble. Noise from these devices may be encountered even though the offending device be located in a neighbor's home at some distance from the receiver.

Both natural and man-made static are picked up by the aerial and ground systems, as can readily be shown by disconnecting both aerial and ground wires from the set, thus causing the noise to disappear. If the noise interferes too greatly with reception and is not due to atmospheric disturbances as evidenced by reception in neighboring sets, a thorough investigation of electrical machinery in the immediate neighborhood is advised, or the matter should be taken up with your radio dealer or the local electric power company. A noise which continues when the aerial and ground are disconnected is probably due to a defective tube or poor connection in the set.

Most noise picked up by the receiver, whether due to static or the operation of electrical apparatus or machinery, is made up very largely of the higher notes. If, therefore, the tone control of the receiver is turned to the right to produce deeper, more mellow music, the effect of noise on radio reception is greatly minimized. This is an important point to bear in mind since the proper use of the tone control may mean all the difference between enjoying a good program and listening to a succession of static crashes.

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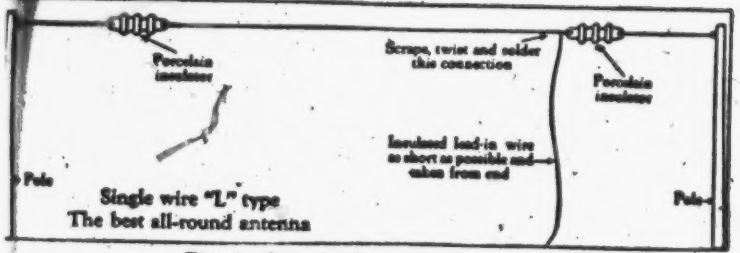

Fig. 1—Standard Single-Wire Aerial

OUTSIDE AERIALS

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imple and very effective aerial, requiring no soldering, is made by using one con- length of No. 14 weather-proof wire to make up aerial and lead-in. **An insu- ire will make as efficient an aerial as a bare wire.**

e continuous length of wire is not used, and no solder is available, a satisfactory y be made by carefully scraping both ends of the wire for several inches and them securely together. The connection should then be well wrapped with tin foil and then taped to make it weather proof. The tin foil must not be since the sulphur contained in most friction tapes will corrode the connection e poor reception eventually unless the foil is used to protect the wire.

LEAD-IN

ntrance to the building may be made through a porcelain tube pushed through illed in the top of the window frame, or by means of a window strip insulator. r way is to carry the lead-in wire over the top of the window. The last method ter insulation than most of the window strips now on the market. If a window ed it is best to solder the wire on both ends rather than rely upon the spring ns which will corrode and cause poor contact within a short space of time.

Cheap window strips are potential sources of trouble. Their insulation is very poor and in damp weather they lose a large percentage of the energy collected by the aerial in addition to causing noises in the set.

Very often **shielded wire,** used as a lead-in, is extremely effective in reducing noises in reception caused by electrical machinery operated in the immediate vicinity.

INSIDE AERIAL

Frequently very satisfactory results may be obtained with an inside aerial consisting of forty to sixty feet of **insulated** wire placed around the picture moulding of a room. Any insulated copper wire may be used.

An inside aerial should not be erected, except where it is impossible to erect an outside one.

It should be remembered that an inside aerial must be just as effectively insulated as an outside one. Often when erecting such an aerial staples are driven through the wire into the wood moulding causing a serious loss of the minute energy collected by the aerial. Insulated staples should be used and care taken when driving them in.

INSTALLATION OF GROUND

Since the ground is an essential part of the aerial system, as much care must be taken in securing a good ground as in erecting a good aerial.

In a great number of installations a satisfactory ground can be made by connecting to a cold water pipe. This connection should be made by soldering the wire directly to the pipe or by some approved form of ground clamp. The pipe should be thoroughly cleaned and all paint and corrosion removed at the point at which the connection is made. Radiators may also be used for grounds, but do not always give good results, particularly **steam radiators,** since they are frequently insulated from ground by non-metallic expansion joints.

When the wiring of a home conforms to underwriters' specifications so that all conduit piping is grounded a wire fastened to the metal plate of a base-board outlet makes a satisfactory ground.

HOW TO CONNECT THE SET

Before connecting up the set, be sure that your home is supplied with the voltage and current for which it is designed, as indicated on the name plate on the rear of the chassis. If you are in doubt, call up your local power company for the necessary information. Connecting the set to a supply outlet furnishing the wrong type of current will result in improper operation or damage.

Your radio receiver is designed to operate at 115 volts. If the voltage in your home rises above 120 volts, you should purchase from your radio dealer a suitable voltage regulator to reduce the line voltage to the proper value so that your radio tubes will give you satisfactory service.

Installation of the set can best be accomplished in the following manner:

1. Remove the set from the packing carton or crate.
2. Remove the packing material holding the tubes in place. Note the two tubes with the small metal caps and the two wires with metal clips made to fit over these caps. Fit the clips over the tube caps if this has not already been done. The length of the wires is such that the clips cannot be connected to the wrong tubes.
3. If your receiver **is not** used in a short wave combination, connect the aerial to the long blue wire you find in back of the set, and connect the ground to the black wire.
4. If your receiver is used in a short wave combination, the aerial and ground should be connected as explained in the separate short wave instruction book.
5. Plug the extension cord of the set into the most convenient outlet. It is now ready for operation.

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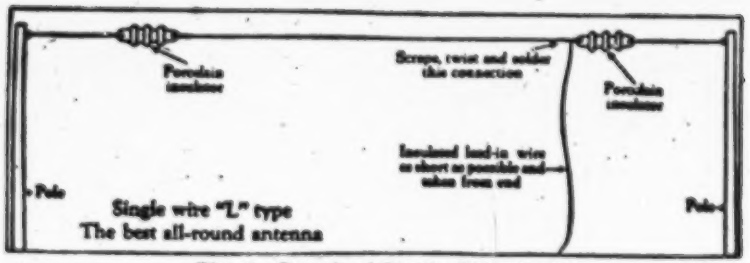

Fig. 1—Standard Single-Wire Aerial

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The aerial proper should consist of copper wire insulated at each end with a glazed porcelain or glass insulator.

In erecting the aerial, be sure it is kept as far as possible from buildings, trees and other obstructions. Do not run it alongside of electric light wires, a tin roof, or any metallic structure.

Avoid placing the aerial above or below exposed wires installed by the Electric Light or Telephone Company.

The best aerial for general use is a simple "L" type, illustrated in Fig. 1. It should be erected as high as possible, as such an aerial will have less directional properties and less tendency to pick up power line interference than a low aerial with a long horizontal lead. The lead-in should come to the set by the most direct route, and should be kept away from the side of the building by porcelain knobs. **It must always be securely soldered to the aerial.**

Very frequently this point is overlooked when installing an aerial, as it is generally inconvenient to do any soldering on the roof. A method that may conveniently be employed is to solder the lead-in wire on to the aerial about three feet from the end before taking it up to the roof where it is usually too difficult to do any effective soldering.

A simple and very effective aerial, requiring no soldering, is made by using one continuous length of No. 14 weather-proof wire to make up aerial and lead-in. **An insulated wire will make as efficient an aerial as a bare wire.**

If one continuous length of wire is not used, and no solder is available, a satisfactory joint may be made by carefully scraping both ends of the wire for several inches and twisting them securely together. The connection should then be well wrapped with ordinary tin foil, and then taped to make it weather-proof. The tin foil must not be omitted, since the sulphur contained in most friction tapes will corrode the connection and cause poor reception eventually unless the foil is used to protect the wire.

LEAD-IN

The entrance to the building may be made through a porcelain tube pushed through a hole drilled in the top of the window frame, or by means of a window strip insulator. A simpler way is to carry the lead-in wire over the top of the window. The last method offers greater insulation than most of the window strips now on the market. If a window strip is used it is best to solder the wire on both ends rather than rely upon the spring connections which will corrode and cause poor contact within a short space of time.

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TUNING INSTRUCTIONS

the set by rotating the switch-tone control knob (Fig. 2) to the right **enough to allow the switch to snap on.** Turning this knob further one control, which should not be adjusted until later.

ttention to a sizzling or crackling noise that may be heard when rned on for the first time or after a long period of idleness. This d by an automatic forming process going on in the self-healing filter con- set, and stops in a few minutes.

he volume control about half way to the right.

Fig. 2 Operating Controls

few seconds for the tubes to warm up. There should be a slight rushing und coming from the speaker to indicate the set is ready to be operated. sound is not heard, turn the volume control further toward the right; turn the volume control to the left.

rn the center tuning control slowly to bring in stations. You will notice n occupies a certain amount of space on the dial in which its volume re-

mains fairly constant. Move the tuning pointer forward and back to determine the width of this space, and then finally set the pointer exactly in the center. This point will give you best tone quality with full representation of all the deep bass notes. Although it will be possible to obtain somewhat greater volume on either side of this correct tuning point, particularly on local stations, the tone will be harsh and shrill, accompanied by hissing and crackling noises.

This tuning action, which is obtained with all automatic volume control receivers, is quite different from the tuning of radio receivers not having this feature. It is therefore highly important to tune the set very carefully, going up and back through the station at least once or twice to be sure that you stop at exactly the point that gives the deepest, richest tone quality. This will require a little practice at first, as the tendency will be to stop tuning too soon, or to tune a little to either side of the correct point, since this results in slightly greater volume, even though tone quality is poorer. The point to remember is that you must tune for the lowest tone, and NOT for the greatest volume.

As a result of the automatic volume control, the sensitivity of the receiver increases as you tune away from a station, so that the slight static noises always present in the air increase at the same time. This accounts for the crackling and frying noises heard between stations. To reduce this noise as much as possible, learn to tune with the volume control turned as far to the left as practical, and bring up the volume to the correct value **after** the station is tuned in correctly.

5. After the desired station is tuned in correctly, the tone control may be adjusted to suit the individual requirements of the listener. **With the tone control all the way toward the left, music is reproduced with the greatest clarity and faithfulness to the original.** As this control is turned toward the right, the lower tones receive more and more emphasis, so that the music takes on an apparently deeper pitch. The best setting for the tone control obviously depends entirely upon the personal preference of the listener.

In addition to regulating tone, the tone control has a very important function in reducing static and those interference noises created by the operation of electrical machinery. As it happens, these crackling and frying noises are very largely composed of the higher tones, so that turning the tone control toward the right reduces this interference to a very great extent.

6. The number system on the dial of your radio receiver is conveniently calibrated to indicate broadcasting station frequencies in kilocycles. However, the final zero has been omitted from the dial numbers, so that dial number 110 corresponds to 1100 kilocycles, dial position 55 to 550 kilocycles, and so on.

7. It may be noticed occasionally when listening to distant stations that the background noise increases and decreases in a regular fashion, although the program itself does not fluctuate in volume. This is due entirely to fading of the incoming wave (See Page 4). The automatic volume control prevents any change in volume, but as the signal tends to fade out, the sensitivity of the set automatically increases, and the static that is always present becomes greater in proportion to this weaker signal and is, therefore, heard more loudly.

8. To shut off the set, turn the switch-tone control all the way back to the left until the sharp click of the switch is heard and the pilot light in back of the dial goes out.

PLAINTIFFS' EXHIBIT NO. 93, Sheet 9,
397-398
698

TUNING INSTRUCTIONS

1. Turn on the set by rotating the switch-tone control knob (Fig. 2) to the right **only just far enough to allow the switch to snap on.** Turning this knob further operates the tone control, which should not be adjusted until later.

Pay no attention to a sizzling or crackling noise that may be heard when the set is turned on for the first time or after a long period of idleness. This noise is caused by an automatic forming process going on in the self-healing filter condensers of the set, and stops in a few minutes.

2. Turn the volume control about half way to the right.

Fig. 2 Operating Controls

3. Wait a few seconds for the tubes to warm up. There should be a slight rushing or crackling sound coming from the speaker to indicate the set is ready to be operated. If the crackling sound is not heard, turn the volume control further toward the right; if it is too loud, turn the volume control to the left.

4. Now turn the center tuning control slowly to bring in stations. You will notice that each station occupies a certain amount of space on the dial in which its volume remains fairly constant. Move the tuning pointer forward and back to determine the width of this space, and then finally set the pointer exactly in the center. This point will give you best tone quality with full representation of all the deep bass notes. Although it will be possible to obtain somewhat greater volume on either side of the correct tuning point, particularly on local stations, the tone will be harsh and shrill, accompanied by hissing and crackling noises.

This tuning action, which is obtained with all automatic volume control receivers, is quite different from the tuning of radio receivers not having this feature. It is therefore highly important to tune the set very carefully, going up and back through the station at least once or twice to be sure that you stop at exactly the point that gives the deepest, richest tone quality. This will require a little practice at first, as the tendency will be to stop tuning too soon, or to tune a little to either side of the correct point, since this results in slightly greater volume, even though tone quality is poorer. The point to remember is that you must tune for the lowest tone, and NOT for the greatest volume.

As a result of the automatic volume control, the sensitivity of the receiver increases as you tune away from a station, so that the slight static noises always present in the air increase at the same time. This accounts for the crackling and frying noises heard between stations. To reduce this noise as much as possible, learn to tune with the volume control turned as far to the left as practical, and bring up the volume to the correct value **after** the station is tuned in correctly.

5. After the desired station is tuned in correctly, the tone control may be adjusted to suit the individual requirements of the listener. **With the tone control all the way toward the left, music is reproduced with the greatest clarity and faithfulness to the original.** As this control is turned toward the right, the lower tones receive more and more emphasis, so that the music takes on an apparently deeper pitch. The best setting for the tone control obviously depends entirely upon the personal preference of the listener.

In addition to regulating tone, the tone control has a very important function in reducing static and those interference noises created by the operation of electric machinery. As it happens, these crackling and frying noises are very largely composed of the higher tones, so that turning the tone control toward the right reduces this interference to a very great extent.

6. The number system on the dial of your radio receiver is conveniently calibrated to indicate broadcasting station frequencies in kilocycles. However, the final zero has been omitted from the dial numbers, so that dial number 110 corresponds to 1100 kilocycles, dial position 55 to 550 kilocycles, and so on.

7. It may be noticed occasionally when listening to distant stations that the background noise increases and decreases in a regular fashion, although the program itself does not fluctuate in volume. This is due entirely to fading of the incoming wave (See Page 4). The automatic volume control prevents any change in volume, but when the signal tends to fade out, the sensitivity of the set automatically increases, and the static that is always present becomes greater in proportion to this weaker signal and is, therefore, heard more loudly.

8. To shut off the set, turn the switch-tone control all the way back to the left until the sharp click of the switch is heard and the pilot light in back of the dial goes out.

TUBES USED

...bes used and their position in the set is shown in Fig. 3.

...8 type tube is identical in appearance to the '57, the only difference between ... as far as the eye can judge, being in the tube number stamped into the bakelite ...hen replacing tubes it is, therefore, necessary to exercise care so as not to ...ge them. While the set will operate with a '57 tube in a '58 socket or vice ...rformance will be very poor.

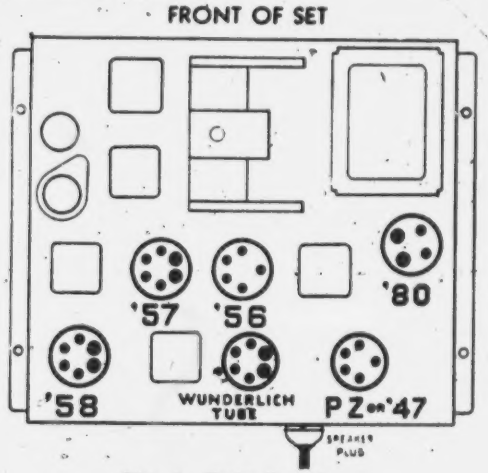


Fig. 3—Tube Positions

RECEIVING SHORT WAVES

...t wave reception brings to the broadcast listener a form of entertainment far ...t from that provided by his broadcast receiver. A good short wave converter ...places the world at his finger tips at all hours of the day. A slight movement ...al and he is listening to England; another position and Paris is at hand; still ...and Germany is heard from. A search closer home brings him the exciting, ...-minute police calls, laden with action and mystery. For a far different type ...e may listen to air-plane pilots requesting and receiving weather reports and ...ections from their ground stations to enable them to safely pilot their planes ...og and storm.

...radio dealer can supply you with a short wave converter made especially for ...so that you can enjoy both broadcast and short wave programs. Complete ...ns for reception of short waves are supplied with the converter.

SUGGESTIONS

...e is poor

...You may have a defective tube.
Your aerial or ground may be poor. Inside aerials very seldom give as much volume as outside ones.
You may be shielded by a steel building.
You may not have followed instructions. Read the instructions again very carefully, making certain that you have followed them exactly.
The line voltage may be low.
You may have a '57 tube in the '58 socket.
The aerial lead-in connection may be broken.
The aerial wire may be disconnected from the set.

If the set hums—

1. Test your tubes or, if possible, try other tubes.

If the set tunes broadly—

1. Your aerial may be too long.
2. Your ground system may be too long. This is quite common if the radio set is located several floors above the ground, or a steam system that is not grounded is being used as a ground.

If tone quality is poor—

1. The tone control may not be adjusted properly.
2. You may have a poor output pentode tube.
3. The speaker may be defective.

WARRANTY

This is to certify that we, the STEWART-WARNER CORPORATION, Chicago, Illinois, warrant the Stewart-Warner Radio Receiver manufactured by us, to be free from defects in material and workmanship under normal use and service, our obligation under this warranty being limited to repairing or replacing, through an accredited Stewart-Warner distributor, any part or parts of said product that in our judgment show evidence of such defect provided that said product shall have been registered with us at the time of purchase; and provided further, that said product shall be returned to the distributor, transportation prepaid, within 90 days from the date of delivery thereof by the dealer to the purchaser.

This warranty is expressly in lieu of all other warranties, expressed or implied, and of all other obligations on our part, and no representative or other person is authorized or permitted to make any warranty or assume for this corporation any liability not strictly in accordance with the foregoing.

This warranty shall not apply to any product which has been tampered with or altered in any way, or which has been subjected to misuse, negligence or accident, or which has the serial number altered, effaced or removed.

We make no warranty whatsoever in respect to accessories or parts not manufactured by us, as they are usually warranted by their respective manufacturers.

IN WITNESS WHEREOF, this warranty is endorsed by the

Stewart-Warner Corporation, Chicago.

PLAINTIFFS' EXHIBIT NO. 93, Sheet 10, 399— 400 699

TUBES USED

The tubes used and their position in the set is shown in Fig. 3.

The '58 type tube is identical in appearance to the '57, the only difference between the two as far as the eye can judge, being in the tube number stamped into the bakelite base. When replacing tubes it is, therefore, necessary to exercise care so as not to interchange them. While the set will operate with a '57 tube in a '58 socket or vice versa, performance will be very poor.

FRONT OF SET

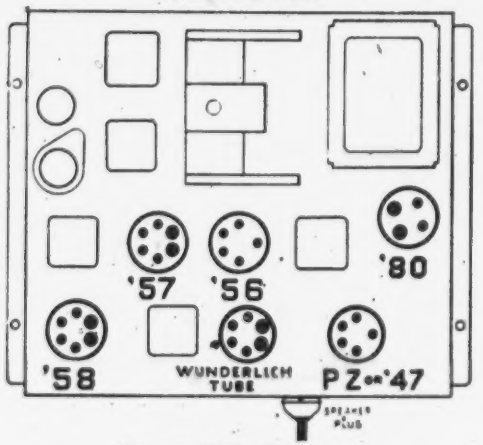


Fig. 3—Tube Positions

RECEIVING SHORT WAVES

Short wave reception brings to the broadcast listener a form of entertainment far different from that provided by his broadcast receiver. A good short wave converter literally places the world at his finger tips at all hours of the day. A slight movement of the dial and he is listening to England; another position and Paris is at hand; still another and Germany is heard from. A search closer home brings him the exciting, up-to-the-minute police calls, laden with action and mystery. For a far different type of thrill he may listen to air-plane pilots requesting and receiving weather reports and flying directions from their ground stations to enable them to safely pilot their planes through fog and storm.

Your radio dealer can supply you with a short wave converter made especially for your set so that you can enjoy both broadcast and short wave programs. Complete instructions for reception of short waves are supplied with the converter.

SUGGESTIONS

If Volume is poor

1. You may have a defective tube.
2. Your aerial or ground may be poor. Inside aerials very seldom give as much volume as outside ones.
3. You may be shielded by a steel building.
4. You may not have followed instructions. Read the instructions again very carefully, making certain that you have followed them exactly.
5. The line voltage may be low.
6. You may have a '57 tube in the '58 socket.
7. The aerial lead-in connection may be broken.
8. The aerial wire may be disconnected from the set.

If the set hums—

1. Test your tubes or, if possible, try other tubes.

If the set tunes broadly—

1. Your aerial may be too long.
2. Your ground system may be too long. This is quite common if the radio is located several floors above the ground, or a steam system that is not grounded is being used as a ground.

If tone quality is poor—

1. The tone control may not be adjusted properly.
2. You may have a poor output pentode tube.
3. The speaker may be defective.

WARRANTY

This is to certify that we, the STEWART-WARNER CORPORATION, Chicago, Illinois, warrant the Stewart-Warner Radio Receiver manufactured by us, to be free from defects in material and workmanship under normal use and service, our obligation under this warranty being limited to repairing or replacing, through an accredited Stewart-Warner distributor, any part or parts of said product that in our judgment show evidence of such defect provided that said product shall have been registered with us at the time of purchase; and provided further, that said product shall be returned to the distributor, transportation prepaid, within 90 days from the date of delivery thereof by the dealer to the purchaser.

This warranty is expressly in lieu of all other warranties, expressed or implied, and of all other obligations on our part, and no representative or other person is authorized or permitted to make any warranty or assume for this corporation any liability not strictly in accordance with the foregoing.

This warranty shall not apply to any product which has been tampered with or altered in any way, or which has been subjected to misuse, negligence or accident, or which has the serial number altered, effaced or removed.

We make no warranty whatsoever in respect to accessories or parts not manufactured by us, as they are usually warranted by their respective manufacturers.

IN WITNESS WHEREOF, this warranty is endorsed by the

Stewart-Warner Corporation, Chicago.

PLAINTIFFS' EXHIBIT NO. 93, Sheet 11,

IMPORTANT!

YOUR Stewart-Warner Radio Receiver is not guaranteed unless you have filled in and mailed the warranty card accompanying each set within ten days after the purchase of the set. Be sure and ask your dealer for this card if it does not accompany the set.

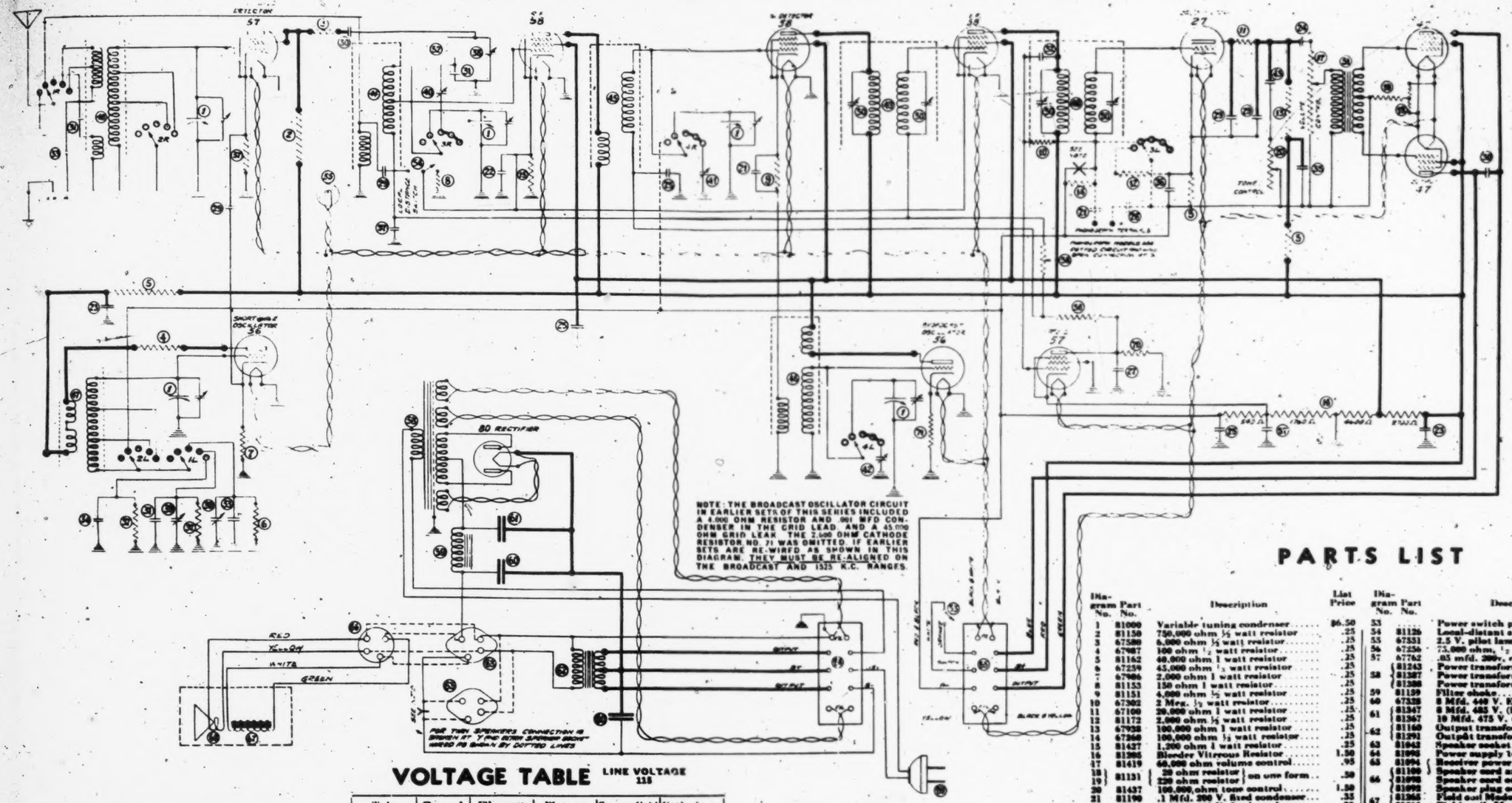
STEWART-WARNER CORPORATION

CHICAGO, ILL., U. S. A.

Form 5607—6-13-32

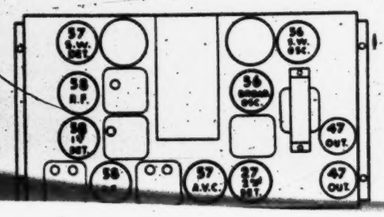
Printed in U.S. A.

CHASSIS MODEL 105 RECEIVER MODELS 50 to 59



TUBE LOCATIONS

FRONT OF SET



VOLTAGE TABLE

LINE VOLTAGE 115

Tube Circuit	Type of Tube	Filament Voltage	Plate to Chassis	Screen Grid to Chassis	Cathode to Chassis
Short Wave Oscillator	56	2.4	81		6.2
Short Wave Detector	57	2.4	21	21	1.9
R. F.	58	2.4	188	102	2.4
Broadcast Oscillator	56	2.4	102		0
First Detector	58	2.4	188	102	9
I. F.	58	2.42	188	102	2.2
A. V. C.	57	2.44	0	0	—39
Second Detector	27	2.42	79		—32
Output	47	2.4	177	188	Fil. to chassis —67 Fil. to grid

CAUTION

Reading must be taken with the set tuned to one of the short wave ranges, and the local - distance switch pulled out.

All D.C. voltages are measured between the tube socket terminal and chassis, using a high resistance voltmeter of 1000 ohms per volt. Readings will vary depending upon voltage range of meter, being higher for higher range instruments. This variation is most marked for all detector and oscillator D.C. voltages.

Readings taken with set testers plugged into tube sockets may deviate considerably

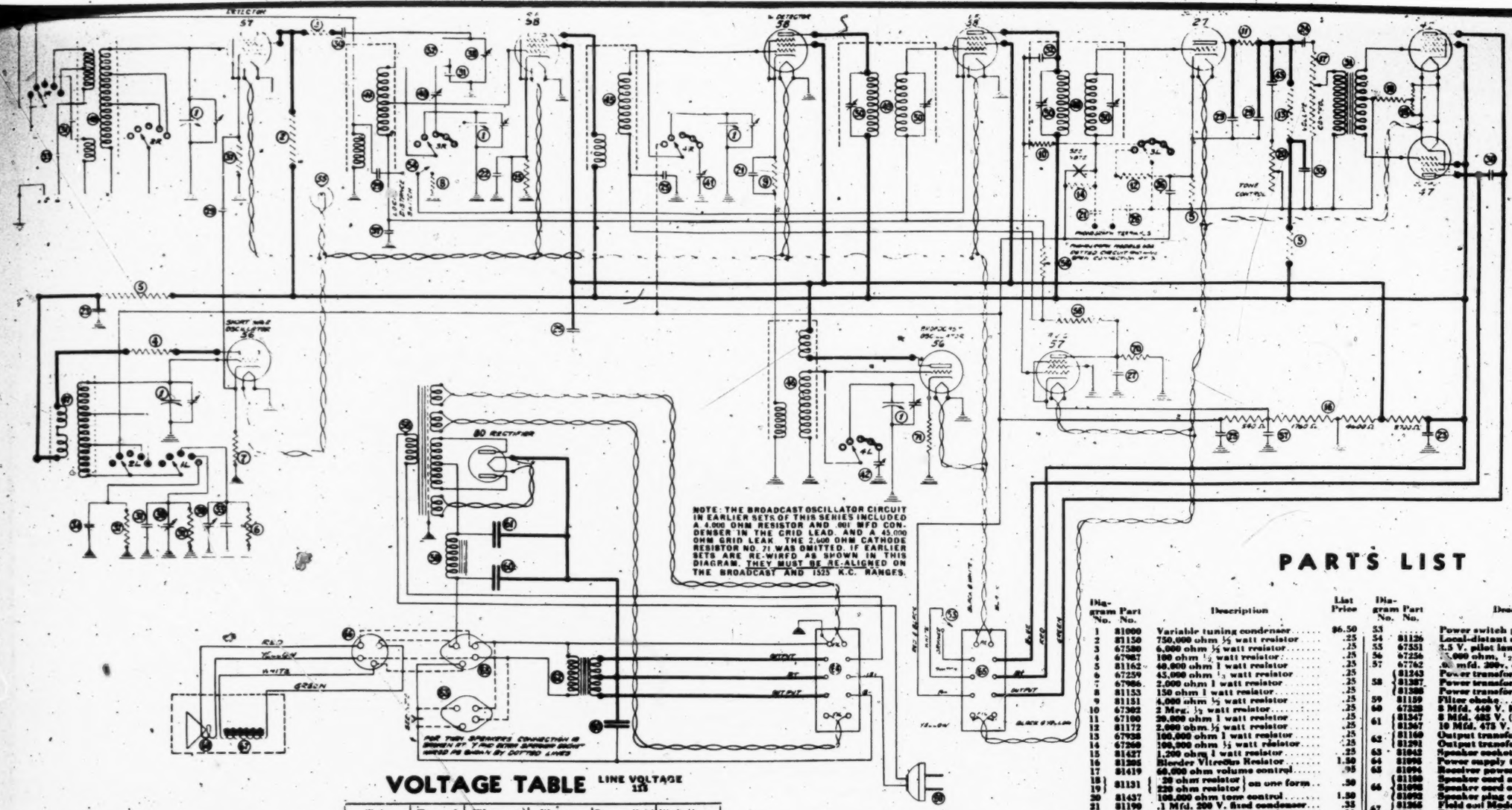
PARTS LIST

Diagram No.	Part No.	Description	List Price
1	81000	Variable tuning condenser	$6.50
2	81150	750,000 ohm ½ watt resistor	.25
3	67580	6,000 ohm ½ watt resistor	.25
4	67987	100 ohm ½ watt resistor	.25
5	81162	40,000 ohm 1 watt resistor	.25
6	67259	45,000 ohm ½ watt resistor	.25
7	67986	2,000 ohm 1 watt resistor	.25
8	81153	150 ohm 1 watt resistor	.25
9	81151	4,000 ohm ½ watt resistor	.25
10	67302	2 Meg. ½ watt resistor	.25
11	67100	20,000 ohm 1 watt resistor	.25
12	81172	2,000 ohm ½ watt resistor	.25
13	67938	100,000 ohm 1 watt resistor	.25
14	67260	100,000 ohm ½ watt resistor	.25
15	81427	1,200 ohm 1 watt resistor	.25
16	81366	Bleeder Vitreous Resistor	1.50
17	81419	60,000 ohm volume control	.95
18	81131	20 ohm resistor } on one form	.50
19		220 ohm resistor }	
20	81437	100,000 ohm tone control	1.50
21	81190	.1 Mfd. 200 V. fixed condenser	.35
22	67294	.1 Mfd. 200 V. fixed condenser	.30
23	67296	.1 Mfd. 400 V. fixed condenser	.40
24	81191	.1 Mfd. 400 V. fixed condenser	.45
25	67297	.25 Mfd. 200 V. fixed condenser	.40
26	81345	.25 Mfd. 200 V. fixed condenser	.45
27	67299	.02 Mfd. 400 V. fixed condenser	.30
28	81333	.02 Mfd. 400 V. fixed condenser	.35
29	81186	.001 Mfd. fixed condenser	.30
30	81415	.002 Mfd. 1000 V. fixed condenser	.35
31	81155	.0005 Mfd. fixed condenser	.25
32	81157	.00025 Mfd. fixed condenser	.25
33	81158	.0001 Mfd. fixed condenser	.25
34	81282	.005 Mfd. fixed condenser	.30
35	81081	.5 Mfd. 400 V. fixed condenser	.50
36	81083	.1 Mfd. 100 V. fixed condenser	.75
37	81152	10,000 ohm ½ watt resistor	.25
38	81366	Trimmer Condenser	.50
39	81231	Trimmer Condenser	.50
40	81365	Trimmer Assembly	.40
41	81301	Double trimmer condenser } one	.60
42		Double trimmer condenser } unit	
43	81445	.02 Mfd. 400 V. fixed condenser	.60
44	81189	"A" Tuning coil	1.00
45	81188	"B" Tuning coil	1.00
46	81187	"C" Tuning coil	1.00
47	81178	Tuning coil	1.00

Diagram No.	Part No.	Description	List Price
53		Power switch part of 81137	
54	81126	Local-distant switch	.60
55	67351	2.5 V. pilot lamp	.25
56	67256	75,000 ohm, ½ watt resistor	.25
57	67762	.05 mfd. 200v. condenser	.35
58	81243	Power transformer, 115 V. 60 cyc.	10.75
	81287	Power transformer, 115 V. 25 cyc.	12.75
	81288	Power transformer, 230 V. 60 cyc.	14.00
59	81139	Filter choke	2.75
60	67328	8 Mfd. 440 V. Electrolytic cond.	1.75
61	81347	8 Mfd. 485 V. (for 60 cycles)	1.75
	81367	10 Mfd. 475 V. (for 25 cycles)	2.00
62	81140	Output transformer, single speaker	2.75
	81291	Output transformer, twin speaker	2.75
63	81042	Speaker socket	.15
64	81095	Power supply terminal socket	.30
65	81094	Receiver power terminal plug	.45
	81100	Speaker cord and plug	.60
66	81098	Speaker cord only	.30
	81099	Speaker plug only	.30
67	81265	Field coil Model R-309-A (400 ohm)	3.50
	81266	Field coil Models RL-309-A or RH-309-A (220 ohm)	3.50
68	81276	Diaphragm Assembly (Model R-309-A)	2.75
	81276	Diaphragm Assembly (Model RL-309-A)	2.75
	81279	Diaphragm Assembly (Model RH-309-A)	2.75
69	81346	Cord and plug	.60
70	81309	1, Meg. ½ watt resistor	.30

Miscellaneous Parts

	81241	Felt Knob Washer	06.01
	67263	No. 6 Special screw for bottom	.20
	67964	I. F. Short Tube Shield	.30
	81097	Tube Shield Cover	.35
	81011	Escutcheon Plate	.15
	81012	Tube Shield Shell	.15
	81099	Terminal Plug Cover	.20
	81107	Small Rubber Drive Bushing	.25
	81171	Large Rubber Drive Bushing	.25
	81210	R. F. Coil Shield	.35
	81212	I. F. Coil Shield	.30
	81213	B. F. Coil Shield	.30



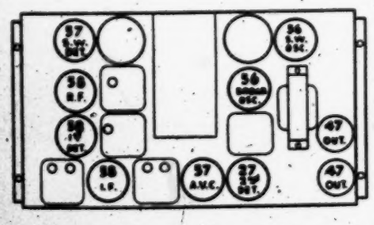
VOLTAGE TABLE

LINE VOLTAGE 115

Tube Circuit	Type of Tube	Filament Voltage	Plate to Chassis	Screen Grid Chassis	Cathode to Chassis
Short Wave Oscillator	56	2.4	81	-	8.2
Short Wave Detector	57	2.4	21	21	1.9
R. F.	58	2.4	188	182	2.4
Broadcast Oscillator	56	2.4	182		0
First Detector	58	2.4	186	182	9
I. F.	58	2.62	188	182	3.2
A. V. C.	57	2.44	0	0	—89
Second Detector	27	2.62	70		—82
Output	47	2.8	177	188	Fil. to chassis —97 Fil. to grid 16.5
Rectifier	80	4.9			

TUBE LOCATIONS

FRONT OF SET



NOTE: Use an 80 tube in the Power Unit.

CAUTION

Reading must be taken with the set tuned to one of the short wave ranges, and the local-distance switch pulled out.

All D.C. voltages are measured between the tube socket terminal and chassis, using a high resistance voltmeter of 1000 ohms per volt. Readings will vary depending upon voltage range of meter, being higher for higher range instructions. This variation is most marked for all detector and oscillator D.C. voltages.

Readings taken with set testers plugged into tube sockets may deviate considerably from the values given in this table, due to their internal circuit arrangements.

PARTS LIST

Diagram No.	Part No.	Description	List Price
1	81000	Variable tuning condenser	$6.50
2	67150	750,000 ohm ½ watt resistor	.25
3	67500	6,000 ohm ½ watt resistor	.25
4	67987	100 ohm ½ watt resistor	.25
5	81162	40,000 ohm 1 watt resistor	.25
6	67259	45,000 ohm ½ watt resistor	.25
7	67986	2,000 ohm 1 watt resistor	.25
8	81153	150 ohm 1 watt resistor	.25
9	67500	6,000 ohm ½ watt resistor	.25
10	67302	2 Meg. ½ watt resistor	.25
11	67100	20,000 ohm 1 watt resistor	.25
12	81172	2,000 ohm ½ watt resistor	.25
13	67938	100,000 ohm 1 watt resistor	.25
14	67266	100,000 ohm ½ watt resistor	.25
15	81427	1,200 ohm 1 watt resistor	.25
16	81286	Bleeder Vitreohm Resistor	1.50
17	81419	60,000 ohm volume control	.95
18	81131	20 ohm resistor } on one form	.50
19		220 ohm resistor }	
20	81437	100,000 ohm tone control	1.00
21	81196	.1 Mfd. 200 V. fixed condenser	.35
22	67294	.1 Mfd. 200 V. fixed condenser	.30
23	67296	.1 Mfd. 400 V. fixed condenser	.40
24	81191	.1 Mfd. 400 V. fixed condenser	.45
25	67297	.25 Mfd. 200 V. fixed condenser	.40
26	81345	.25 Mfd. 200 V. fixed condenser	.45
27	67295	.02 Mfd. 400 V. fixed condenser	.30
28	81333	.02 Mfd. 400 V. fixed condenser	.35
29	81186	.001 Mfd. fixed condenser	.30
30	81415	.002 Mfd. 1000 V. fixed condenser	.35
31	81185	.0005 Mfd. fixed condenser	.25
32	81157	.00025 Mfd. fixed condenser	.30
33	81158	.0001 Mfd. fixed condenser	.25
34	81332	.005 Mfd. fixed condenser	.30
35	81081	.5 Mfd. 400 V. fixed condenser	.50
36	81083	.1 Mfd. 100 V. fixed condenser	.75
37	81153	10,000 ohm ½ watt resistor	.25
38	67288	Trimmer Condenser	.50
39	81251	Trimmer Condenser	.50
40	81302	Trimmer Assembly	.40
41	81301	Double trimmer condenser } one	.60
42		Double trimmer condenser } unit	
43	81445	.02 Mfd. 400 V. fixed condenser	.40
44	81189	"A" Tuning coil	1.00
45	81190	"B" Tuning coil	1.00
46	81406	"C" Tuning coil	1.00
47	81178	Tuning coil	1.30
48	81179	Tuning coil	1.75
49	81254	I.F. transformer coils	1.00
50	81200	I.F. tuning condensers	.40
51	81276	Input push-pull transformer	2.75
52	81305	R.F. choke coil	.35
53		Power switch part of 81437	
54	81126	Local-distant switch	.40
55	67551	2.5 V. pilot lamp	.25
56	67256	5,000 ohm, ½ watt resistor	.25
57	67762	.05 mfd. 200 v. condenser	.35
58	81243	Power transformer, 115 V. 60 cyc.	10.75
	81287	Power transformer, 115 V. 25 cyc.	12.75
	81288	Power transformer, 230 V. 60 cyc.	14.50
59	81189	Filter choke	2.75
60	67328	8 Mfd. 440 V. Electrolytic cond.	1.75
61	81347	8 Mfd. 485 V. (for 60 cycles)	1.75
	81367	10 Mfd. 473 V. (for 25 cycles)	2.00
62	81160	Output transformer, single speaker	2.75
	81291	Output transformer, twin speaker	2.75
63	81043	Speaker socket	.15
64	81098	Power supply terminal socket	.30
65	81094	Receiver power terminal plug	.45
66	81180	Speaker cord and plug	.40
	81098	Speaker cord only	.30
	81093	Speaker plug only	.20
67	81366	Field coil Model RL-309-A (400 ohm)	3.50
	81366	Field coil Models RL-309-A or RH-309-A (200 ohm)	3.50
68	81274	Diaphragm Assembly (Model R-309-A)	2.75
	81276	Diaphragm Assembly (Model RL-309-A)	2.75
	81279	Diaphragm Assembly (Model RH-309-A)	2.75
69	81346	Cord and plug	.40
70	81509	½ Meg. ½ watt resistor	.30

Miscellaneous Parts

61241	Felt Knob Washer	$0.01
67263	No. 6 Special screw for bottom	.20
67964	I. F. Short Tube Shield	.20
81007	Tube Shield Cover	.10
81011	Escutcheon Plate	.15
81012	Tube Shield Shell	.15
81099	Terminal Plug Cover	.10
81109	Small Rubber Drive Bushing	.05
81111	Large Rubber Drive Bushing	.05
81210	S. W. Coil Shield	.10
81212	I. F. Coil Shield	.10
81215	R. F. Coil Shield	.10
81252	Range Switch	.75
81268	Colored Dial Cord and Frame	.50
81701	Tone or Volume Control Knob	.10
81702	Large Tuning Knob	.15
81703	Range Switch Lever	.10

PLAINTIFFS' EXHIBIT NO. 93, Sheet 13,

SERVICE DATA for STEWART-WARNER 105 SERIES CHASSIS (RECEIVER MODELS 50 to 59)

CIRCUIT DESCRIPTION OF 105 RECEIVER

GENERAL:

The Model 105 Stewart-Warner Radio Receiver is an 11-tube ac wave receiver, using a double superheterodyne circuit, which thru the use of a multi-section range switch permits the use of any one of four tuning ranges or phonograph hook-up as desired.

CIRCUIT LAYOUT:

Thru the use of the range switch radio signals are made to follow one of two general circuit paths, depending on their wave lengths. If the signal is in the broadcast band, it is fed directly to the tuned input circuit of the R.F. tube, and from there on amplified in the usual way. During broadcast reception interference from short wave stations is prevented by applying a very high negative bias on the short wave oscillator tube, preventing it from functioning.

When the set is switched over to any one of the three short wave ranges, the following circuit changes are made:

1. The antenna is switched to the tuned input circuit of the short wave detector.
2. The bias on the short wave oscillator tube is reduced so that it can function.
3. The tuning condenser sections in the R.F., first detector, and broadcast oscillator stages are cut out of the circuit and replaced by fixed trimmer condensers which are adjusted to tune these circuits to pass a 1525 K.C. signal. This frequency is used to prevent pickup of broadcast band stations during short wave reception.

The received short wave signal passes thru the short wave detector, where it is converted to 1525 K.C. by the action of the short wave oscillator and it is then amplified at this frequency in the broadcast section of the receiver.

Input to the second detector tube is kept constant regardless of variation in signal strength by means of an A.V.C. circuit using a separate 37 tube. Volume is regulated by means of a variable resistor acting as a voltage divider to feed the primary of the input push-pull transformer.

EXPLANATION OF RANGE SWITCH:

The range switch consists of eight independent switch sections, each section being provided with five contacts. Ordinarily only seven sections of the eight, and only four contacts of the five per switch are used, the remainder being wired in on phonograph models only.

In the circuit diagram these different switch sections are labelled 1R, 1L, 2R, etc., and for the sake of simplicity are shown in different locations in the diagram, altho they are all parts of the master range switch assembly located in the center of the chassis. With the chassis bottom-side up and controls pointing away from you 1R is the front right hand section, 1L is the front left hand section, 2R is the second right-hand section counting from the front of the chassis, and so on.

Switch contact positions are arranged in the following order reading in a clockwise direction.

1. PHONOGRAPH. — This contact is used on phonograph models only. On all other sets, the switch lever cannot be moved to this position.
2. BROADCAST RANGE. — In non-phonograph models a stop has been placed to prevent the switch from turning on to Point No. 1 so that No. 2 is really the first switch position.
3. 180-80 METER SHORT WAVE RANGE.
4. 80-33 METER SHORT WAVE RANGE.
5. 33-14 METER SHORT WAVE RANGE.

As the range switch is rotated in a clockwise direction the following circuit changes are effected.

POSITION 1. Phonograph. (This position is available on phonograph models only.) Switch 1R grounds the aerial, while switch 4R biases the first detector to cut off, thus rendering it inoperative. These circuit changes prevent radio interference while the phonograph is being used. Switch 3L, which is wired in on phonograph models only, makes the necessary connections to bias the second detector as an amplifier instead of a detector.

POSITION 2. Broadcast [illegible]. (This is the first position in use on non-phonograph models.) In this position switch 2L biases the short wave oscillator to stop it from oscillating, so that the short wave section cannot cause interference when receiving stations on the broadcast band. Switch 1R connects the aerial to the primary of the R.F. coil. Switch 3R connects the third section of the variable condenser gang across the secondary of the R.F. coil. Switch 4R connects the fifth section of the variable condenser gang across the secondary of the first detector coil. Switch 4L connects the fourth section of the variable condenser gang across the secondary of the broadcast oscillator circuit. In phonograph models only, switch 3L connects the secondary of the second I.F. transformer directly to B minus.

POSITION 3. 180 to 80 Meter Short Wave Band. In this position switch 1R connects the aerial to one of the two tuned primaries of the short wave detector. Switch 3R connects the output of the short wave detector to the secondary of the R.F. coil, and also connects an adjustable trimmer condenser across the secondary of this coil to tune it to 1525 K.C. Switch 4R connects an adjustable trimmer across the secondary of the first detector coil to tune it to 1525 K.C. Switch 4L connects a variable trimmer across the secondary of the broadcast oscillator to tune it to 1702.5 K. C., thus giving an I.F. of 177.5 K.C. Switch 1L connects an adjustable padding circuit in series with the secondary of the short wave oscillator coil, thus permitting proper tracking of this circuit in this short wave band. In phonograph models only, switch 3L connects the secondary of the second I.F. transformer directly to B minus.

POSITION 4. 80 to 33 Meter Short Wave Band. In this position switch 1R connects the aerial to the second of the two primaries of the short wave detector coil. Switch 2R shorts out a portion of the secondary of the short wave detector coil, thus enabling it to tune to the 33 to 80 meter band. Connections to switches 3R, 4R and 4L remain the same as in position 3, tuning the R.F. section to 1525 K.C. Switch 1L connects a different adjustable padding circuit in series with the secondary of the short wave oscillator coil, thus permitting proper tracking of this circuit in this short wave band. Switch 2L shorts out part of the secondary of the short wave oscillator coil so that it will tune to wave lengths between 33 and 80 meters. In phonograph models only, switch 3L connects the secondary of the second I.F. coil directly to B minus.

POSITION 5. 33 to 14 Meter Short Wave Band. In this position switch 1R connects the aerial thru a tap to the second primary of the short wave detector coil. Switch 2R shorts out a larger section of the secondary of the short wave detector coil so that this circuit can be tuned from 14 to 33 meters. Connections thru switches 3R, 4R, 3L and 4L remain as in positions 3 and 4. Switch 1L connects a non-adjustable padding circuit in series with the secondary of the short wave oscillator coil. Switch 2L shorts out a larger portion of the secondary of the short wave oscillator coil, thus permitting this tuned circuit to cover the 14 to 33 meter band.

LOCAL-DISTANCE SWITCH:

The local-distance or "quiet" switch, which is operated by an in-and-out motion of the tone control knob, functions in the following manner. In the "in" or local position, the primary of the R.F. coil is shunted by a fixed condenser, thus by-passing part of the signal to ground and reducing the signal input into this circuit. The R.F. and I.F. tubes are operated at a high negative bias to reduce their amplification. In the "out" or distance position, the by-passing condenser is cut out of the circuit and a fixed resistor is connected in parallel with the bias resistor of the R.F. and I.F. tubes, thus reducing the bias on these tubes to its normal value, permitting them to operate at maximum sensitivity.

(Continued on last page)

SPEAKER:

Three different types of speakers are used with the 105 set.

(1) R-208-A. This is the standard model for single speaker receivers. Its field coil resistance is 460 ohms.

(2) RL-209-A. This is the LOW unit of a twin speaker set. Its field coil resistance is 230 ohms.

(3) RH-209-A. This is the HIGH unit of a twin speaker set. Its field coil resistance is 230 ohms.

Replacement diaphragms for RL-209-A and RH-209-A are marked 67208 and 81268 respectively.

POWER UNIT:

Altho the chassis are the same, different power units are used for the single and twin speaker sets. The twin speaker power unit has two speaker sockets instead of one, and a different output transformer, designed to handle two speakers.

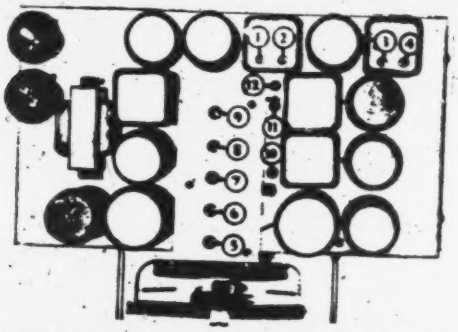
ALIGNING THE MODEL 105 RECEIVER

There are five distinct circuits to be aligned in the 105 receiver. The order in which they are given below is the order in which they must be aligned.

(1) Intermediate Frequency Amplifier (177.5 K.C.)
(2) Broadcast Tuning Circuit (540-1550 K.C.)
(3) Short Wave Intermediate Frequency Amplifier (1525 K.C.)
(4) First Short Wave Circuit (180 to 80 meters)
(5) Second Short Wave Circuit (80 to 33 meters)

NOTE: The third short wave circuit requires no aligning since both condensers will be in step if short wave circuits (4) and (5) are properly aligned.

In aligning the Model 105 it is essential to use a high grade oscillator and a sensitive output meter. The R.F. signal fed



into the receiver must be very weak or it will cause the A.V.C. circuit to function, making correct alignment impossible. The output meter must be sufficiently sensitive to give a satisfactory reading with this low signal.

Before starting the alignment of the set, see that the volume control is full on, the local-distance switch pulled out, and the output meter connected to the pentode plates thru .25mfd. condensers, or to the voice coil of the speaker. The tone control should be turned all the way to the right. This last step is helpful in reducing the tube "shish" and makes aligning easier.

(1) ALIGNING THE I. F. CIRCUITS AT 177.5 K. C.

Remove the grid clip from the first detector tube and connect the two output terminals of the oscillator in series with the grid clip and grid cap of the tube. Set the oscillator to exactly 177.5 K.C. and adjust its output to give about one-half scale deflection of the output meter.

Carefully adjust the four I.F. trimmers Nos. 1, 2, 3 and 4 (see diagram) until output is at a maximum. After all four trimmers have once been adjusted, go back and readjust them again in the same order, since any change made in one affects the others to some extent so that readjustment is necessary. If any static is coming thru the receiver so that the output meter fluctuates, pull out the broadcast oscillator tube to prevent this interference from coming thru.

(2) ALIGNING BROADCAST R. F. CIRCUITS

In this, and all subsequent steps in alignment, remove the A.V.C. tube.

Before starting this alignment procedure, it is necessary to check the calibration of the set on the broadcast band, since this band must subsequently be used as a reference point in aligning the three short wave bands. This calibration check is very important. It can easily be done by disconnecting the test oscillator and tuning in some broadcast station between 1000 and 1400 K.C. whose frequency is definitely known.

If the dial reading of the set corresponds to the broadcast frequency of the station, the set is in calibration. If the dial reading is incorrect, turn the dial pointer to the proper frequency and carefully adjust trimmer No. 8 until the station is tuned in with maximum volume.

After the receiver is calibrated it must be aligned. To do this connect the test oscillator to the set aerial and ground terminals and set it to approximately 1400 K.C. Tune the set to this signal. Carefully adjust trimmers No. 7 and No. 9 for maximum output. Retune the set, which is thrown out of resonance when trimmers No. 7 and No. 9 are adjusted, and once more adjust these trimmers. Repeat this procedure until you are certain the output cannot be increased by further adjustment.

(3) ALIGNING SHORT WAVE I. F. AT 1525 K. C.

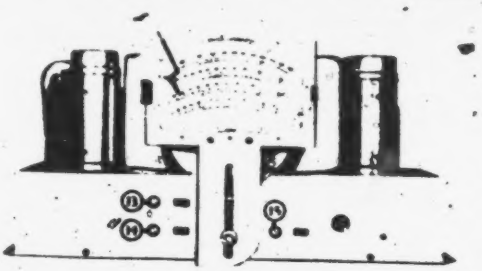
Adjust the test oscillator to exactly 1525 K.C. by setting the broadcast receiver to this frequency and tuning the oscillator until the signal comes thru with maximum volume. Now shift the tuning range of the set to the second short wave band (80 to 33 meters). Adjust the oscillator output to give about one-half full scale deflection. If static is bad, causing the output meter needle to jump about, remove the short wave oscillator tube.

Using a Bakelite screwdriver, adjust trimmers Nos. 10, 11 and 12 to give maximum output.

NOTE: It should never be necessary to adjust the following short wave circuits unless the short wave trimmers or coils have been changed or tampered with. Alignment procedure as a rule should not go beyond this point.

(4) ALIGNING 180-80 METERS SHORT WAVE BAND

The following alignment procedure is extremely critical. Tune the receiver to exactly 800 K.C. and adjust the output frequency of the test oscillator until its signal is a maximum at this frequency. Shift to the first short wave band of the set, and turn the pointer as far as it will go to the left. This tunes the set to 1600 K.C., which is the second harmonic of



the test oscillator signal. Adjust trimmer No. 14 until this signal comes thru with maximum output.

Again using the calibrated broadcast band, set the test oscillator output to exactly 975 K.C., shift back to the first short wave band, and turn the pointer as far as it will go to the right. Adjust trimmer No. 5 until the oscillator signal (4th harmonic of 975 K.C.) is picked up with maximum output. If it has been necessary to change the adjustment of trimmer No. 5 appreciably, go back to trimmer No. 14 and adjust it again as outlined at the beginning of this section. This second readjustment is important.

(5) ALIGNING 80-33 METERS SHORT WAVE BAND

Set the test oscillator to exactly 925 K.C. using the method previously outlined for 800 K.C. and 975 K.C. Shift the tuning range of the set to the second short wave band (80-33 meters) and turn the pointer as far as it will go to the left. Adjust trimmer No. 13 until the fourth harmonic of the 925 K.C. signal comes thru with maximum output.

Set the test oscillator at 1500 K.C., using the method previously outlined. Tune in the signal at approximately 50 meters, which is the 4th harmonic of 1500 K.C. and adjust trimmers Nos. 6 and 15 until the oscillator signal comes thru with maximum output. Retune the set and readjust trimmers 6 and 15. Trimmer No. 15 is not at all critical in its action.

NOTE: It is very important that the aligning frequencies given in sections 3, 4 and 5 be exact, otherwise both the calibration and sensitivity, particularly at the third short wave band, will be badly off.

REVISIONS

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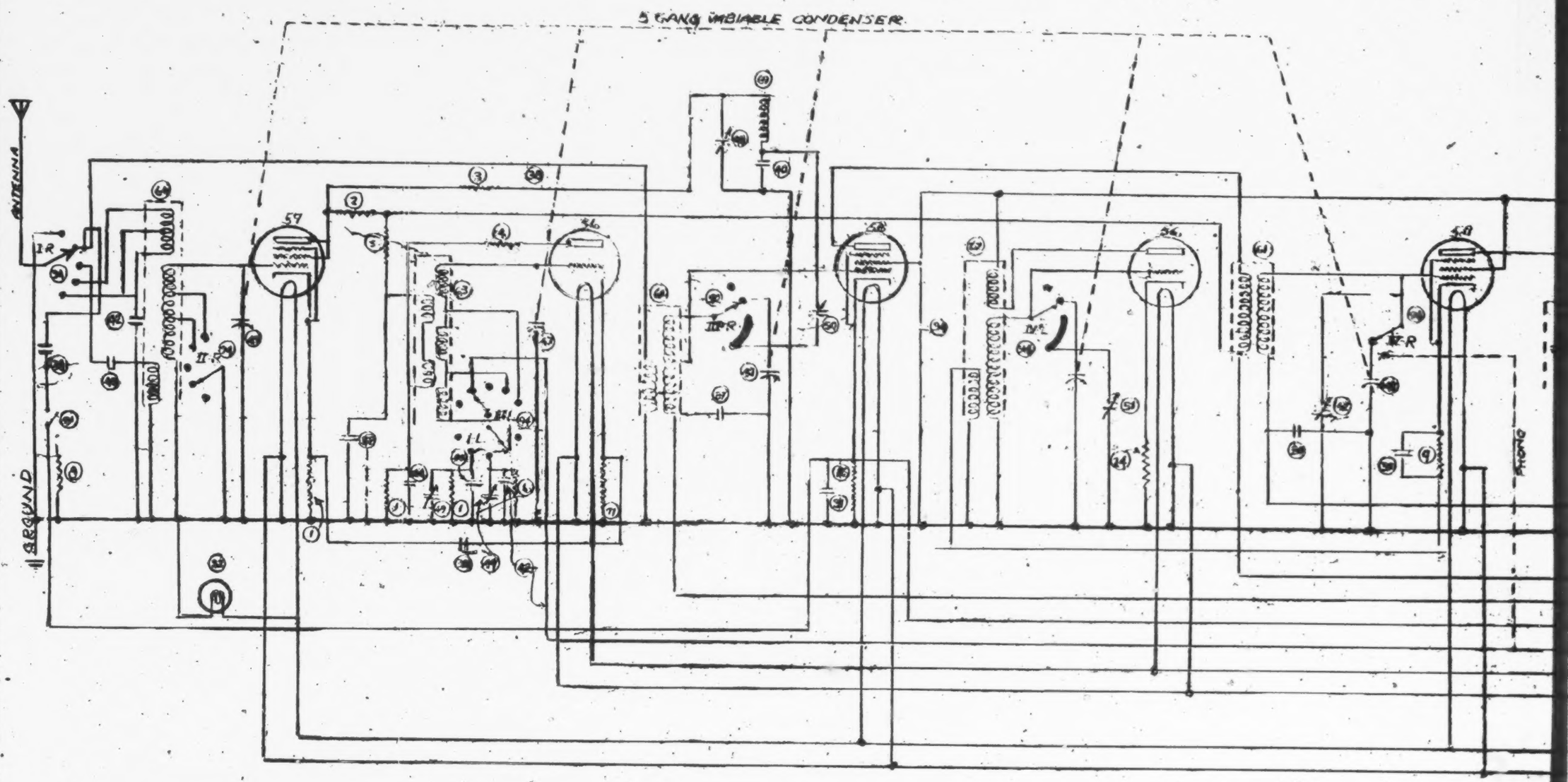
THIS PRINT SUPERSEDES ANY PRINT DATED PRIOR TO

IN-407

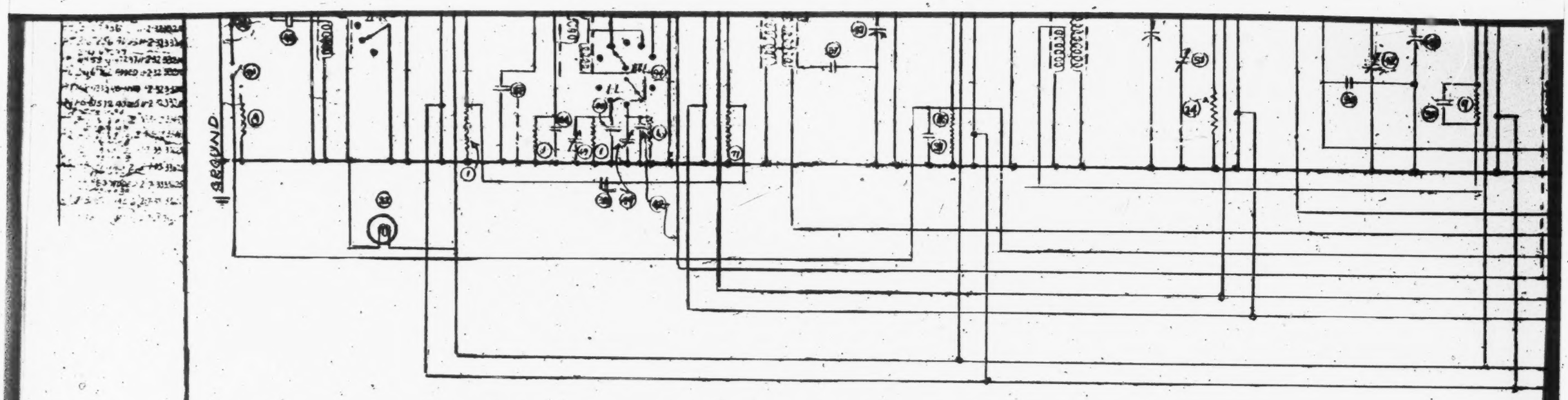
PLAINTIFFS' EXHIBIT NO. 93 SHEET 15
(Blueprint marked IN-407)



3	1	81152	10,000Ω	½ WATT FIXED RESISTOR
1	2	8050	750000Ω	½ WATT FIXED RESISTOR
1	3	67590	6000Ω	¼ WATT FIXED RESISTOR
1	4	67987	100Ω	½ WATT FIXED RESISTOR
3	5	81162	40000Ω	1 WATT FIXED RESISTOR
1	6	61253	45000Ω	¼ WATT FIXED RESISTOR
1	7	67986	2000Ω	1 WATT FIXED RESISTOR
1	8	81153	150Ω	1 WATT FIXED RESISTOR
				½ WATT FIXED RESISTOR

1	34	G-81190 FIXED COND. .1-200V. WITH CLIP (USED ON PHONO)
1	35	G-67294 FIXED COND. .1-200V. WITHOUT CLIP
2	36	G-67296 FIXED COND. .1-400V. WITHOUT CLIP
1	39	G-81191 FIXED COND. .1-400V. WITH CLIPS
3	54	G-67237 FIXED COND. .25-200V. WITHOUT CLIP
1	37	G-81345 FIXED COND. .125-200V. WITH CLIP (FOR PHONO ONLY)
1	38	G-67299 FIXED COND. .02-400V. WITHOUT CLIP
1	39	G-81572 FIXED COND. .05-200V. WITH CLIP
5	28	81156 FIXED COND. .001

1	40	G-81187 "A" COIL ASSEM.
1	41	G-81188 "B" COIL ASSEM.
1	42	G-81406 "C" COIL ASSEM
1	43	G-81178 OSC. COIL ASSEM
1	44	G-81179 DET. COIL ASSEM
1	45	G-81236 1ST INTER. TRANS. ASSEM
1	46	G-81331 2ND INTER. TRANS. ASSEM
1	47	G-81276 INPUT TRANS. & ANT. COIL



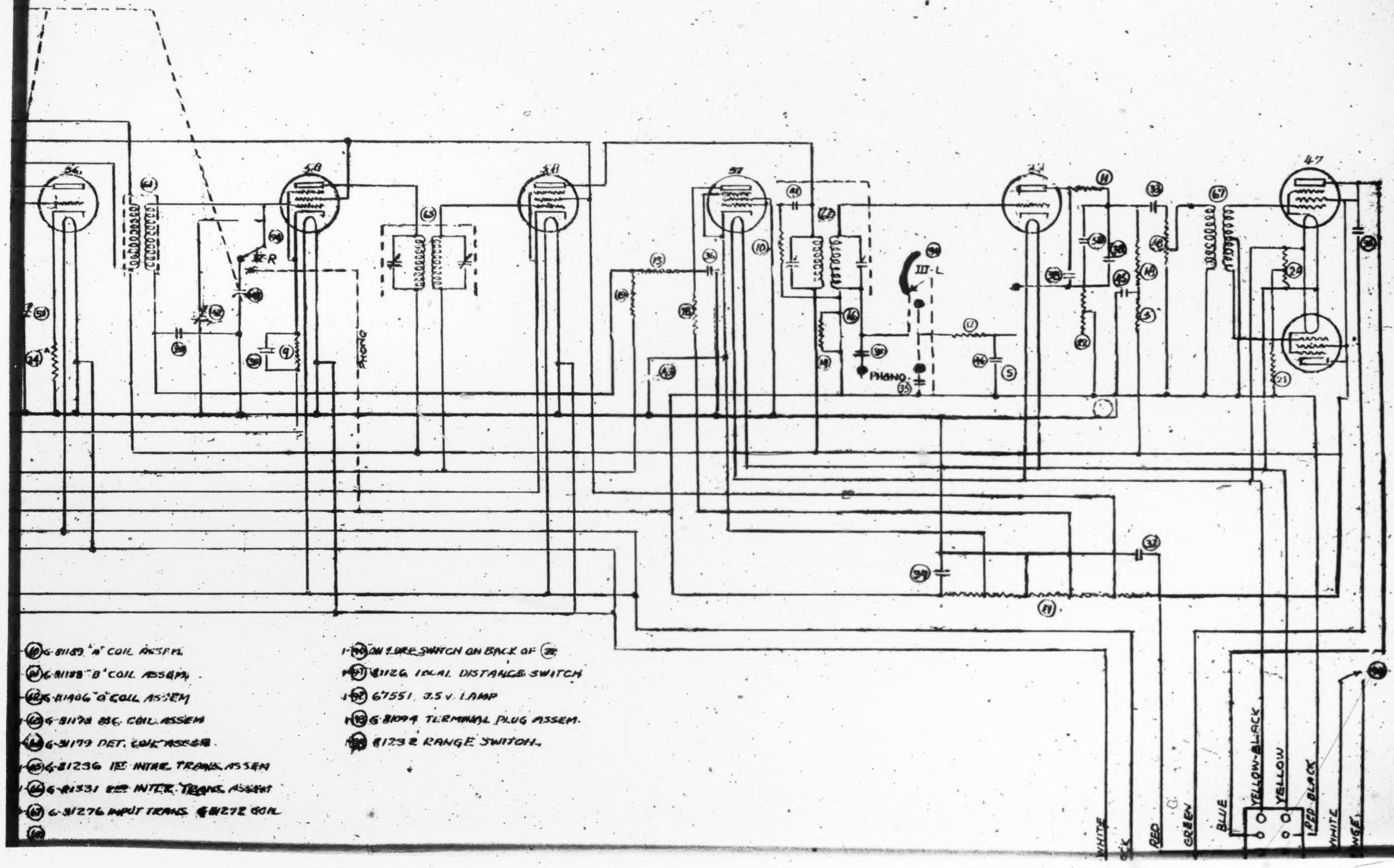
3-(1) 31152 18000Ω 1/2 WATT FIXED RESISTOR
1-(2) 8050 750000Ω 1/2 WATT FIXED RESISTOR
1-(3) 67590 6000Ω 1/4 WATT FIXED RESISTOR
1-(4) 67987 100Ω 1/2 WATT FIXED RESISTOR
3-(5) 81162 40000Ω 1 WATT FIXED RESISTOR
1-(6) 61253 45000Ω 1/4 WATT FIXED RESISTOR
1-(7) 67986 2000Ω 1 WATT FIXED RESISTOR
1-(8) 81153 150Ω 1 WATT FIXED RESISTOR
1-(9) 6451 4000Ω 1/2 WATT FIXED RESISTOR
1-(10) 67952 2.4 MEG 1/2 WATT FIXED RESISTOR
1-(11) 67100 20000Ω 1 WATT FIXED RESISTOR
1-(12) 81172 2000Ω 1/4 WATT FIXED RESISTOR (PHONO ONLY)
1-(13) 67933 100000Ω 1 WATT FIXED RESISTOR
1-(14) 67260 50000Ω 1/4 WATT FIXED RESISTOR (PHONO ONLY)
1-(15) 81429 1200Ω 1 WATT FIXED RESISTOR
(16) OPEN CIRCUIT AT THIS POINT (FOR PHONO ONLY.)
1-(17) 81205 BLEEDER REGISTOR
1-(18) 81419 VOL CONTROL 60000Ω
2-(19) 67256 75,000Ω 1/2 WATT FIXED RESISTOR
(20) 1- 91131 FIXED REGISTOR 120Ω CENTER TAP
(21) 91131 FIXED RESISTOR 220Ω
1-(22) 91457 TONE CONTROL 100,000Ω
1-(23) 81509 5000Ω 1/2 WATT FIXED RESISTOR
1-(24) 81829 1500 1/4 WATT FIXED RESISTOR

1-(30) G-81190 FIXED COND. .1-200V. WITH CLIP (USED ON PHONO)
1-(31) G-67294 FIXED COND. .1-200V. WITHOUT CLIP
2-(32) G-67296 FIXED COND. .1-400V. WITHOUT CLIP
1-(33) G-81191 FIXED COND .1-400V WITH CLIPS
3-(34) G-67297 FIXED COND. .25-200V. WITHOUT CLIP
1-(35) G-81345 FIXED COND. .125-200V. WITH CLIP (FOR PHONO ONLY)
1-(36) G-67299 FIXED COND. .02-400V. WITHOUT CLIP
1-(37) G-81572 FIXED COND. .05-200V. WITH CLIP
5-(38) 81156 FIXED COND. .001
1-(39) G-81345 FIXED COND. .002 WITHOUT CLIP
3-(40) 81155 FIXED COND. .0005
1-(41) 81157 FIXED COND. .00025
2-(42) 81158 FIXED COND. .0001
1-(43) G-67262 FIXED COND. .05-200V. WITHOUT CLIP
1-(44) 81282 FIXED COND. .002
1-(45) 81081 FIXED COND .5-400V.
1-(46) 81443 FIXED COND .1-100V.
1-(47) 81000 VARIABLE CONDENSER
1-(48) G-81346 TRIMMER ASSEM. (S.W.)
1-(49) G-81231 TRIMMER ASSEM (S.W.)
1-(50) G-81202 TRIMMER ASSEM. (SINGLE)
(51) G-81201 TRIMMER ASSEM (DOUBLE) FRONT
(52) G-81201 TRIMMER ASSEM (DOUBLE) REAR
1-(53) G-81345 FIXED CONDENSER .02 400V WITH CLIPS

1-(60) G-81189 "A" COIL ASSEM.
1-(61) G-81188 "B" COIL ASSEM.
1-(62) G-81406 "C" COIL ASSEM
1-(63) G-81178 BC COIL ASSEM
1-(64) G-81179 DET. COIL ASSEM
1-(65) G-81236 1ST INTER. TRANS. ASSEM
1-(66) G-81331 2ND INTER. TRANS. ASSEM
1-(67) G-81276 INPUT TRANS. & ANT. COIL
(68)
1-(69) G-81385 UNIVERSAL WAND COIL

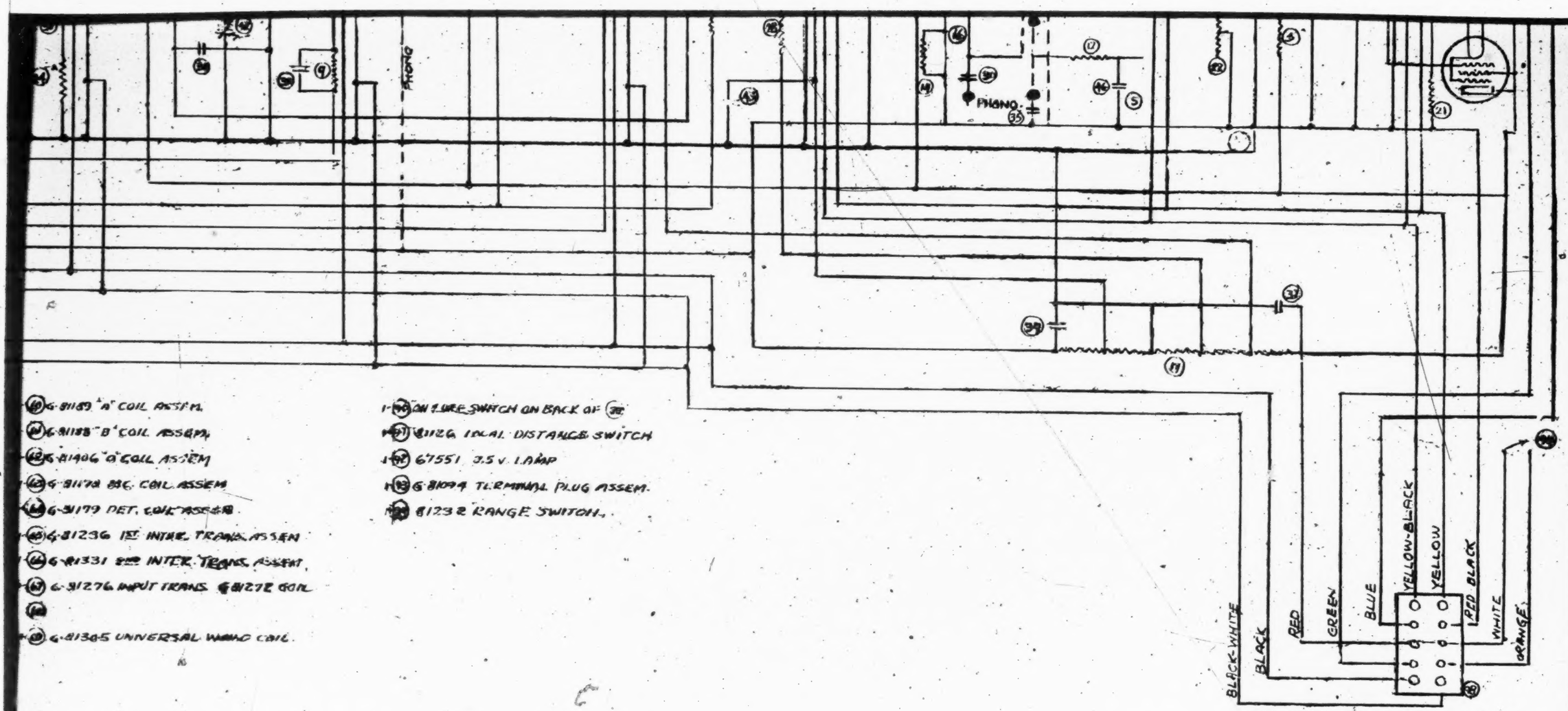
CAUTION

SHEET



(49) G-81189 "A" COIL ASSEM.
(50) G-81188 "B" COIL ASSEM.
(62) G-81406 "C" COIL ASSEM
(63) G-81178 BFO. COIL ASSEM
(64) G-81179 DET. COIL ASSEM
(65) G-81236 1ST INTER. TRANS. ASSEM
(66) G-81331 2ND INTER. TRANS. ASSEM
(67) G-81276 INPUT TRANS. & ANT. COIL
(68)

1-(30) ON TUNE SWITCH ON BACK OF (28)
1-(31) 81126 LOCAL DISTANCE SWITCH
1-(32) 67551 3.5 v. LAMP
1-(33) G-81094 TERMINAL PLUG ASSEM.
1-(34) 81232 RANGE SWITCH.



(60) G-81189 "A" COIL ASS'M.
(61) G-81188 "B" COIL ASSEM.
(62) G-81406 "C" COIL ASS'M
(63) G-81178 B&C COIL ASSEM
(64) G-81179 DET. COIL ASSEM
(65) G-81236 1ST INTER. TRANS. ASSEM
(66) G-81331 2ND INTER. TRANS. ASSEM.
(67) G-81276 INPUT TRANS. & 81278 COIL
(68)
(69) G-81305 UNIVERSAL WIRING COIL.

1-(70) ON TUNE SWITCH ON BACK OF (71)
1-(71) 81126 LOCAL DISTANCE SWITCH
1-(72) 67551 3.5 V. LAMP
1-(73) G-81094 TERMINAL PLUG ASSEM.
1-(74) 81232 RANGE SWITCH.

G-81472	60W SPEC. VOLT	MODEL	R-105-EF
G-81471	25W 115V	MODEL	R-105-BE
G-81470	60W 115V	MODEL	R-105-AF
G-81355	60W SPEC. VOLT	MODEL	R-105-ETF
G-81354	25W 115V.	MODEL	R-105-BTF
G-81353	60W 115V.	MODEL	R-105-ATF
G-81357	25W 115W	MODEL	R-105-BT
G-81356	60W 115W	MODEL	R-105-AT
G-81351	25W 115V.	MODEL	R-105-B
G-81350	60W 115V.	MODEL	R-105-A
CHASSIS	TYPE OF CHASSIS	USED ON	NO

STEWART-WARNER CORPORATION, CHICAGO, U. S. A.

NAME CIRCUIT DIAGRAM (REC. MECH. ASSEM.)
NUMBER IN 407

PLAINTIFFS' EXHIBIT No. 93, Sheet 16,

INSTRUCTIONS

FOR

STEWART-WARNER

SERIES 50

RADIO RECEIVERS

(CHASSIS 105-A, B and E)

WHAT TO EXPECT FROM YOUR STEWART-WARNER RADIO RECEIVER

Your new Stewart-Warner All-Wave Duo-Superheterodyne is the most modern development in radio reception, for it combines all that is new with the old in radio.

All-Wave reception offers two distinctly different types of radio entertainment: First, the reliable every day reception of broadcast programs; and second, the thrills of direct reception from foreign countries, the excitement of police calls and airplane communications, and the kick of listening to transatlantic phone conversation, television, experimental broadcasts in endless variety, and amateurs discussing their trials and tribulations in their own peculiar jargon. When you sit down to your receiver you never know what thrill short wave reception will bring to your home, for the short wave stations you heard so clearly yesterday or the day before may now be inaudible and superseded by others offering an entirely different variety of entertainment.

Naturally, you want to derive the greatest possible benefit from this new radio thrill—short wave reception—but in order to do so it is absblutely necessary that you carefully read the guides to short wave reception that follow.

Many people take it for granted that because the same tuning controls are used for both broadcast and short wave reception there are no differences between these two types of reception—such is not the case.

Short wave reception presents many peculiarities not encountered in the reception of longer wave programs, and it is necessary for even the experienced operator of broadcast sets to become thoroughly familiar with the many differences, both in reception and tuning experienced when operating a short wave set. While we cannot discuss in detail all of these differences, we will cover briefly the most important ones in the following pages.

TUNING FOR SHORT WAVES IN THE CORRECT PORTIONS OF THE DIAL

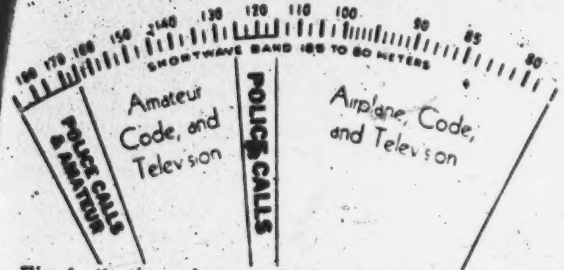


Fig. 1. Stations that may be found on the 80 to 200 meter short wave band.

Fig. 2. Stations that may be found on the 33 to 80 meter short wave band.

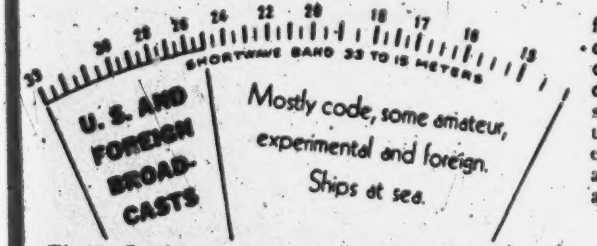


Fig. 3. Stations that may be found on the 15 to 33 meter short wave band.

In the broadcast band there are 96 station channels and one or more stations send out programs on every one of them so that it is an easy matter to pick up stations at will. **The short wave band has twenty times as many, or 1900, station channels and only a small number of them contain programs of interest to the average listener.**

These channels are grouped into compact bands at a few definite points on the dial so that a large portion of the total dial space has no entertainment value, being restricted to code. Because of the relatively wide spaces between entertainment bands, many people spend a large proportion of their time uselessly hunting for interesting short wave programs where none can be found.

You are most likely to find entertaining programs on the underlined portions of the three short wave dials. Do most of your short wave tuning in these underlined portions. However, stations may be found at some time or other on any portion of the dial.

Figures 1, 2, and 3 illustrate the three short wave dials, indicating the types of programs that may be tuned in at the various wave lengths. The entertaining programs are indicated in bold type and correspond to the underlined portions of the dials.

CHOOSING THE BEST WAVE LENGTHS FOR THE TIME OF DAY

Short wave reception on certain wave lengths is frequently more satisfactory during the day than at night, while on the other wave lengths the reverse is true. It will, therefore, be found that short wave stations operating on some wave lengths, will come in during the day only, while others will not come in until after sunset. For example, 15 to 33 meter stations operating to the east of the listener come in best from about 11:00 A. M. to 10:00 P. M., while stations to the west come in best from about midnight until shortly after daybreak.

From 33 to 70 meters, distant stations can be heard only after dark. Very little in the way of extreme distance can be heard above 70 meters, although commercial stations such as police, fire, coast-guard, aircraft, and ships are all above this wave length.

In addition to this difference in reception depending upon directions, the difference in time in various parts of the globe must be taken into consideration. For example, when it is 5:00 P. M. in Chicago, it is midnight in England and 1:00 A. M. in most of Europe, at which time their broadcast stations are off the air. **Consequently tuning for European stations must be attempted during the afternoon.**

Moreover, U. S. short wave stations rarely start broadcasting before 1:00 o'clock in the afternoon, so that the air is almost always silent during the morning.

Failure to take these facts into consideration leads to much useless tuning and resultant dissatisfaction.

GETTING DISTANCE ON SHORT WAVES

Because of the wide interest in reception from extremely distant points, a good deal of exaggeration has attended the claims generally made for short wave reception. Some idea of the difficulties encountered in extreme distance reception is obtained when one considers the fact that, in the broadcast band the reliable working range of a 50,000 watt super-power broadcast station is only 150 miles. This is the maximum distance over which satisfactory reception can be assured, **24 hours in the day.** Of course, we know that such stations often cover ranges in the thousands of miles, but such reception cannot be consistently secured.

The set owner who has this information realizes the unreasonableness of expecting short wave stations with limited powers of only 100 to 1000 watts to provide consistent and satisfactory reception at points thousands of miles away. It is true that low power short wave broadcasts will cover many times the distance of similar broadcasts transmitted on long wave lengths, as is evidenced by the fact that for long distances, satisfactory daylight reception can be secured on the short wave broadcasts of such well known stations as KDKA, WGY, WENR and WLW at locations where their main broadcasts, using many times the power, cannot be heard at all. The important point to remember, however, is that **extreme ranges cannot be counted upon day in and day out.** For example, foreign reception has been realized at many locations situated all over the country, but such reception is highly variable, coming in with excellent volume one day and very poorly, if at all, the next.

PLAINTIFF'S EXHIBIT NO. 93, Sheet 17, 412-413

VARIABLE NATURE OF SHORT WAVE RECEPTION

Set owners must realize that short wave reception varies greatly, depending upon such factors as location of the receiver, time of day, and season of the year. Quite frequently satisfactory short wave reception is obtained in one location, while with similar receiving equipment located only a mile or so away, the same signal cannot even be detected. Fifteen minutes later conditions may be reversed, and the second location secure good reception while the first does not. Such variations are at their worst when distances are extreme, as in the case of foreign reception.

It is frequently possible to receive signals from extremely distant stations, while signals from much nearer stations may not come in at all. This phenomena is known as "skip distance effect" and is frequently encountered on extremely short waves.

Short wave stations also change in volume from time to time, these changes being brought about largely by the amount of daylight between transmitter and receiver. For example, European stations are always best for American listeners during the summer months, while South American stations come in best during the winter.

Fading or fluctuation of volume is also quite common on short waves. Unlike the fading experienced with the longer wave lengths it is very rapid; stations, on occasion, fading in and out several times in one second. In extreme cases fading may be so rapid as to give a peculiar fluttering quality to the music.

IMPORTANCE OF CAREFUL TUNING ON SHORT WAVES

Although the reception of foreign short wave broadcasting stations is no longer an unusual experience for thousands of radio listeners, there are still many owners of short wave receivers who have never heard anything outside of the United States or Canada. Their disappointing failures can almost invariably be traced to their failure to exercise enough care in tuning their sets.

The tuning in of short wave programs is quite critical, and the usual careless turning of the tuning dial that is sufficient to bring in broadcast stations will inevitably fail in short wave reception. Stations may be brought in and tuned out again in but a fraction of a dial division, and unless all tuning instructions are painstakingly followed to the letter, distant stations will invariably be passed by. Some idea of the care required in tuning a short wave receiver may be obtained when one considers that in the one meter band between 49 and 50 meters there are more than twelve full width transmitting channels. This means that unless the tuning knob is turned very slowly most of the short wave stations will be passed by completely.

INTERFERENCE IN SHORT WAVE RECEPTION

Although true static is almost non-existent on short waves, electrical interference set up by the operation of electric machinery is much more severe. Short wave receivers are so sensitive to this type of interference that it is frequently possible to pick up the disturbances caused by the ignition system of a passing automobile.

GENERAL CAUTIONS

Because of the factors we have but briefly touched here, it will require considerable experience and practice before the operator becomes familiar with the possibilities of short wave reception and can tell, by the time of day or season of the year, which short wave band is the most likely to provide best results. Therefore, he should not become discouraged if he does not at once realize the full potentialities of short wave reception.

Due consideration given to the above information and strict adherence to the operating instructions which follow, will materially shorten the time necessary to master the art of short wave tuning.

GENERAL INFORMATION ON BROADCAST RECEPTION

NOISES IN RECEPTION:

Most of the frying or crackling noises heard in a radio receiver when the volume control is well advanced are due to electrical discharges in the atmosphere (known as static) or the operation of electrical machinery in the neighborhood of the set. Such interference may be caused by any motor-driven device, such as a vacuum cleaner, vibrator, etc., since the brushes of electric motors invariably cause a good deal of sparking, or it may be a flashing electric sign an X-ray or violet ray machine, an oil burner, an electric refrigerator, a neon sign, traffic control signal, or similar device. It may even be caused by loose contact of an electric bulb or iron in its socket. Electric heating pads, due to their use of an automatic make and break mechanism for regulating temperature are particularly prone to cause such trouble. Noise from these devices may be encountered even though the offending device may be located in a neighbor's home at some distance from the receiver.

Both natural and man-made static are picked up by the aerial and ground systems, as can readily be shown by disconnecting both aerial and ground wires from the set, thus causing the noise to disappear. If the noise interferes too greatly with reception and is not due to atmospheric disturbances as evidenced by reception in neighboring sets a thorough investigation of electrical machinery in the immediate neighborhood is advised, or the matter should be taken up with your radio dealer or the local electric power company. A noise which continues when the aerial and ground are disconnected is probably due to a defective tube or poor connection in the set.

Most noise picked up by the receiver, whether due to static or the operation of electrical apparatus or machinery, is made up very largely of the higher notes. If, therefore, the tone control of the receiver is turned to the right to produce deeper, more mellow music, the effect of noise on radio reception is greatly minimized. This is an important point to bear in mind since the proper use of the tone control may mean all the difference between enjoying a good program and listening to a succession of static crashes.

PLACING THE RECEIVER FOR BEST TONE:

The location of the set itself has much to do with the quality of music it will provide. If it is placed in a large bare room with no rugs, the sound waves proceeding from it will be reflected from the floors and cause a noticeable loss of tone quality. Fortunately, the average living room has most of its large reflecting surfaces deadened or broken up by rugs, furniture, and curtains, so that reception is normal.

PLAINTIFFS' EXHIBIT NO. 93, Sheet 18, 414 - 415

c coming from a radio set sounds much more pleasing to those in than to one side of the speaker, and therefore, the set should face m.

me at which a set is operated also affects its tone. Best results will when the volume of the radio receiver is about the same as the sic being broadcast. If the volume is reduced appreciably below this lower tones will tend to drop out, giving the music a higher, more On the other hand, if the set is turned full on the lower tones are sized.

t a tone control it is impossible to compensate for this apparent lack lance. However, this change in tone value may be easily rectified rrect use of the tone control. For low volume the tone control may toward the right to help the bass notes, while for great volume, the ol should be turned toward the left to bring out the high notes and the over-emphasis of the bass so that the same realistic reproduction ed at all volume levels.

ANTENNA SYSTEM

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aerial for general use is a single wire erected as high as possible. erial will have less directional properties and less tendency to pick e interference than a low aerial with a long horizontal lead. The d come to the set by the most direct route, and should be kept he side of the building by porcelain knobs. **It must be securely e aerial.**

INSTALLATION OF GROUND

Since the ground is an essential part of the aerial system, as much care must be taken in securing a good ground as in erecting a good aerial.

In a great number of installations a satisfactory ground can be made by connecting to a cold water pipe. This connection should be made by soldering the wire directly to the pipe or by some approved form of ground clamp. The pipe should be thoroughly cleaned and all paint and corrosion removed at the point at which the connection is made. Radiators may also be used for grounds, but do not always give good results, particularly steam radiators, since they are frequently insulated from ground by non-metallic expansion joints.

HOW TO CONNECT THE SET

Before connecting up the set, be sure that your home is supplied with the voltage and current for which it is designed, as indicated on the name plate on the rear of the chassis. If you are in doubt, call up your local power company for the necessary information. Connecting the set to a supply outlet furnishing the wrong type of current will result in improper operation or damage.

Your radio receiver is designed to operate at 115 volts. If the voltage in your home rises above 120 volts, you should purchase from your radio dealer a suitable voltage regulator to reduce the line voltage to the proper value so that your radio tubes will give you satisfactory service.

Installation of the set can best be accomplished in the following manner:

1. Remove the set from packing carton or crate.

2. Remove the packing material holding the tubes in position. Note that some of the tubes have small clips making contact with a cap at the top of the tube. **Be sure the metal clips do not touch the tube shields.**

3. **Loosen the four bolts holding down the set until their heads no longer touch the shelf. Also make sure the knobs do not touch the front panel.**

4. Connect the aerial to the long blue wire you find in back of the set.

5. Connect the ground to the black wire.

6. Plug the extension cord of the set into the most convenient outlet. It is now ready for operation.

TUNING INSTRUCTIONS

Before you can tune your radio receiver, you must first get a clear picture of the purpose of the four controls. These are all illustrated in Fig. 4 on the next page.

1. The knob to the left operates the volume control. Once this is set to give you the desired volume, it need hardly be touched again, since all stations within reach of the set will come in with almost the same volume because of the automatic volume control built into the receiver.

2. The center knob is the **two-speed** tuning control. When this knob is pulled out it connects in the slow-motion tuning control which is required for the extremely fine tuning of short wave stations. When this knob is pushed in, it connects in a rapid action tuning control which is used for broadcast reception, or to pass quickly from one end of the dial to the other when in the short wave ranges. This knob should always be pulled out or pushed in **with a slight twisting motion** to reduce wear on the tuning drive.

PLAINTIFFS' EXHIBIT NO. 93, Sheet 19, 708 419—417

The music coming from a radio set sounds much more pleasing to those in front, rather than to one side of the speaker, and therefore, the set should face into the room.

The volume at which a set is operated also affects its tone. Best results will be obtained when the volume of the radio receiver is about the same as the original music being broadcast. If the volume is reduced appreciably below this value, the lower tones will tend to drop out, giving the music a higher, more reedy tone. On the other hand, if the set is turned full on the lower tones are over-emphasized.

Without a tone control it is impossible to compensate for this apparent lack of tone balance. However, this change in tone value may be easily rectified through correct use of the tone control. For low volume the tone control may be turned toward the right to help the bass notes, while for great volume, the tone control should be turned toward the left to bring out the high notes and counteract the over-emphasis of the bass so that the same realistic reproduction is maintained at all volume levels.

ANTENNA SYSTEM

You should have a good **outside** aerial for your all-wave receiver. Although an indoor aerial will usually give very satisfactory reception of broadcast stations, it cannot be relied upon for good short wave reception.

The most satisfactory aerial for any particular installation will vary widely in different locations, depending largely upon local structural details and sources of interference.

When erecting the aerial always bear in mind the fact that the volume and selectivity of a set are largely governed by the length of the antenna system.

As the length of the aerial is increased, the volume of distant stations will be increased, but the selectivity of the set will be decreased. At the same time reception will become noisier, as a long aerial picks up more interference proportionately.

It must be remembered that in some cases a shorter antenna will bring in more stations than a very long one, as the increased selectivity permits reception without interfefence from nearby stations.

The most suitable aerial for use in large cities or congested radio districts where interference is a serious problem is one whose total length, including lead-in, is from thirty to sixty feet. In rural sections where no interference is obtained and volume is of extreme importance, a total length of 80 to 150 feet may be best.

The following are a few general ideas to be kept in mind when installing an outside antenna.

The aerial proper should consist of copper wire insulated at each end with a glazed porcelain or glass insulator.

In erecting the aerial, be sure it is kept as far as possible from buildings, trees and other obstructions. Do not run it alongside of electric light wires, a tin roof, or any metallic structure.

The best aerial for general use is a single wire erected as high as possible, as such an aerial will have less directional properties and less tendency to pick up power line interference than a low aerial with a long horizontal lead. The lead-in should come to the set by the most direct route, and should be kept away from the side of the building by porcelain knobs. **It must be securely soldered to the aerial.**

INSTALLATION OF GROUND

Since the ground is an essential part of the aerial system, as much care be taken in securing a good ground as in erecting a good aerial.

In a great number of installations a satisfactory ground can be made connecting to a cold water pipe. This connection should be made by solde the wire directly to the pipe or by some approved form of ground clamp. pipe should be thoroughly cleaned and all paint and corrosion removed at point at which the connection is made. Radiators may also be used for grou but do not always give good results, particularly steam radiators, since t are frequently insulated from ground by non-metallic expansion joints.

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3. **Loosen the four bolts holding down the set until their heads no long touch the shelf. Also make sure the knobs do not touch the front panel.**

4. Connect the aerial to the long blue wire you find in back of the set.

5. Connect the ground to the black wire.

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TUNING INSTRUCTIONS

Before you can tune your radio receiver, you must first get a clear picture the purpose of the four controls. These are all illustrated in Fig. 4 on t next page.

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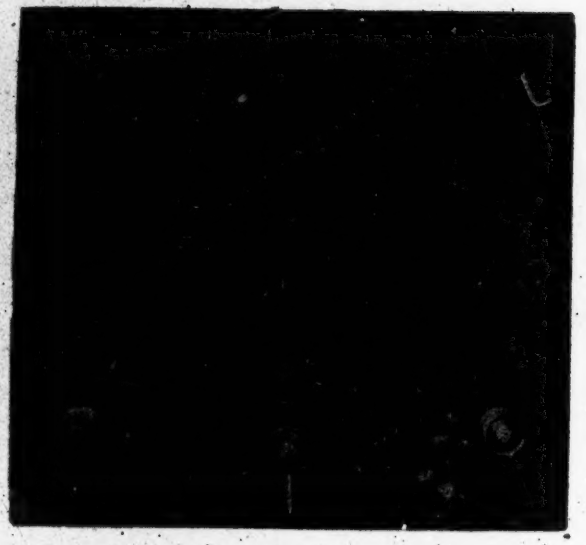

Volume Control — Range Selector — Tuning Control

1. On-Off Switch
2. Local-Distance
3. Tone Control

Fig. 4. Tuning Controls.

The right hand knob has three uses: (a) When turned slightly to the t turns the set on; (b) when turned further to the right it operates as control; (c) when pushed in the set will receive local stations only and the between stations will be cut out completely. For distance reception, this s pulled out.

The range selector lever is used to switch from one tuning range to r.

TUNING THE SET

Before tuning the set, be sure that the right hand control knob is out.

Turn the set on by rotating the right hand control knob to the right t far enough to allow the switch to snap on. Turning the knob further s the tone control, which should not be adjusted until later.

Turn the volume control (left hand knob) about half way to the right.

Wait a few seconds for the tubes to warm up. There should be a slight g or rushing sound coming from the speaker to indicate the set is ready ration. If the crackling sound is not heard, turn the volume control toward the right; if it is too loud, turn it to the left.

5. By means of the range selector lever, switch over to the wave length range you wish to hear. Be sure that this lever clicks definitely into the correct position before proceeding further. If it is left a little to either side of the correct position, interference may result.

6. Now turn the center tuning control slowly to bring in stations. You will notice that each station occupies a certain amount of space on the dial in which its volume remains fairly constant. Move the tuning pointer back and forth to determine the width of this space, and then finally set the pointer exactly in the center. This point will give you the best tone quality with full representation of all the deep bass notes. Although it will be possible to obtain somewhat greater volume on either side of this correct tuning point, particularly on local stations, the tone will be harsh and shrill, accompanied by hissing and crackling noises.

This tuning action, which is obtained with all automatic volume control receivers, is quite different from the tuning of radio receivers not having this feature. It is, therefore, highly important to tune the set very carefully, going up and back through the station at least once or twice to be sure that you stop at exactly the point that gives the deepest, richest tone quality. This will require a little practice at first, as the tendency will be to stop tuning too soon, or to tune a little to either side of the correct point, since this results in slightly greater volume, even though tone quality is poorer. The point to remember is that you must tune for the lowest tone and NOT for the greatest volume.

For local reception, it will be much easier to tune to the correct point if the right hand knob is pushed in.

7. When tuning in any of the short wave ranges, you will usually find that programs of interest will be obtained on those sections of the dial that are underlined. The other portions of the three short wave ranges are mainly restricted to code or commercial use, but an occasional short wave broadcast may be picked up in it.

Figs. 1, 2 and 3 on page 2 illustrate the three short wave ranges and will give you some idea of what type programs may be obtained at any part of the dial.

8. After the desired station is tuned in correctly, the tone control may be adjusted to suit the indivdual requirements of the listener. **With the tone control all the way to the left, music is reproduced with the greatest clarity and faithfulness to the original.** As this control is turned toward the right, the lower tones receive more and more emphasis, so that the music takes on an apparently deeper pitch. The best setting for the tone control depends entirely upon the personal preference of the listener.

In addition to regulating tone; the tone control has a very important function in reducing static and those interference noises created by the operation of electrical machinery. As it happens, these crackling and frying noises are very largely composed of the higher tones, so that turning the tone control toward the right reduces this interference to a very great extent.

9. As a result of the automatic volume control action of the receiver, its sensitivity increases as you tune away from a station so that the static noises always present in the air increase at the same time. This accounts for the crackling and frying noises heard between stations when the right hand knob is pulled out.

If you are listening to local stations only, it is best to push the right hand knob in. This not only eliminates noise between stations, but renders tuning very much easier.

PLAINTIFFS' EXHIBIT NO. 93, Sheet 20.
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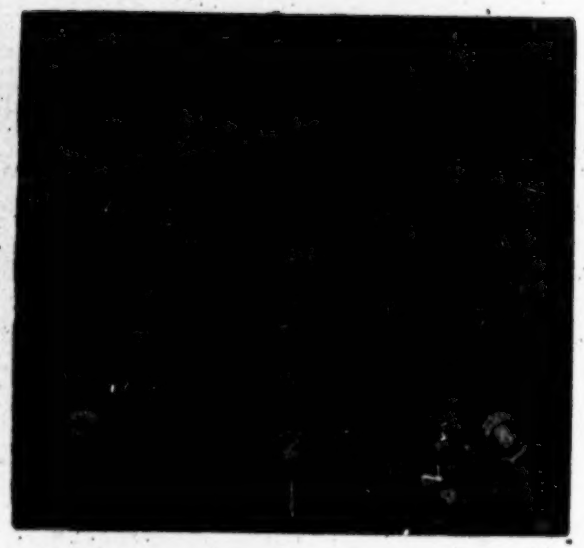

Volume Control | **Range Selector** | **Tuning Control**

1. On-Off Switch
2. Local-Distance
3. Tone Control

Fig. 4. Tuning Controls.

3. The right hand knob has three uses: (a) When turned slightly to the right it turns the set on; (b) when turned further to the right it operates as a tone control; (c) when pushed in the set will receive local stations only and the noise between stations will be cut out completely. For distance reception, this knob is pulled out.

4. The range selector lever is used to switch from one tuning range to another.

TUNING THE SET

1. Before tuning the set, be sure that the right hand control knob is pulled out.

2. Turn the set on by rotating the right hand control knob to the right **only just far enough to allow the switch to snap on.** Turning the knob further operates the tone control, which should not be adjusted until later.

3. Turn the volume control (left hand knob) about half way to the right.

4. Wait a few seconds for the tubes to warm up. There should be a slight crackling or rushing sound coming from the speaker to indicate the set is ready for operation. If the crackling sound is not heard, turn the volume control further toward the right; if it is too loud, turn it to the left.

5. By means of the range selector lever, switch over to the wave range you wish to hear. Be sure that this lever clicks definitely into the position before proceeding further. If it is left a little to either side correct position, interference may result.

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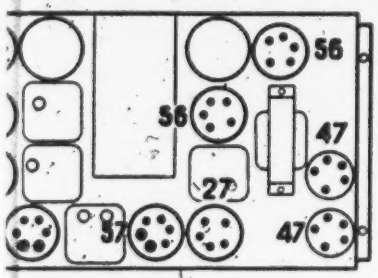
710

...y be noticed occasionally when listening to distant stations that ...nd noise increases and decreases in a regular fashion, although the ...t does not fluctuate in volume. This is due entirely to fading of ...g wave. The automatic volume control prevents any change in ...s the signal tends to fade out, the sensitivity of the set automatic... and the static that is always present becomes greater in proportion ...er signal and is, therefore, heard more loudly. This action is particu...able on the short wave ranges.

...shut off the set, turn the right hand knob all the way back toward ...til the sharp click of the switch is heard and the pilot light back of ...es out.

FRONT OF SET



...TE: Use an 80 tube in the Power Unit Below.

Fig. 5. Tube Positions.

TUBES USED

The tubes used and their position in the set is shown in Fig. 5.

The '58 type tube is identical in appearance to the '57, the only difference between the two as far as the eye can judge, being in the tube number stamped into the bakelite base. When replacing tubes, it is, therefore, necessary to exercise care so as not to interchange them. While the set will operate with a '57 tube in a '58 socket, or vice versa, performance will be very poor.

SUGGESTIONS

...s Poor—

...may have a defective tube.
...aerial or ground may be poor. Inside aerials very seldom give as ...volume as outside ones.
...may be shielded by a steel building.
...may not have followed instructions. Read the instructions again very ...ly, making certain that you have followed them exactly.
...ne voltage may be low.
...may have a '57 tube in the '58 socket.
...erial lead-in connection may be broken.
...erial wire may be disconnected from the set.

...owls—

...ling should occur occasionally when receiving short wave signals; ...volume and carefully retune to the exact station setting and it ...op.

...ity Is Poor—

...ne control may not be adjusted properly.
...ction is not properly tuned in.
...ay have a poor tube.
...eaker may be defective.

SHORT WAVE BROADCAST STATIONS

(Courtesy International Short Wave Radio, Klondyke, Ohio)

Since short wave broadcast schedules change at frequent intervals, we cannot guarantee the accuracy of these log tables. For those who are particularly interested in short wave reception we suggest a subscription to a good short wave magazine, such as "International Short Wave Radio," published in Klondyke, Ohio, which has a very complete log that is brought up to date every month.

(Note—The following group of stations broadcast musical programs. Commercial stations are listed separately.)

Wave Length	Call Letters	Location	Operating Schedule (Eastern Standard Time)
14.47	LSY	Buenos Aires, Argentina.	Near 4 P. M. Sundays.
15.93	PLE	Bandoeng, Java.	Tuesdays, 8:40-10:40 A. M.
19.57	W2XAD	Schenectady, N. Y.	3 to 6 P. M. daily, Sat. & Sun. 1 to 6 P. M.
19.68	.....	Pontoise, France.	7 A. M. to 10 A. M. daily.
19.72	W8XK	Pittsburgh, Pa.	6 A. M. to 4 P. M. daily.
19.73	DJB	Zeesen, Germany.	Irregularly Mon., Fri., Sat. and Sun., 8 A. M. to 4 P. M. Usually 8 A. M. to 1 P. M.
19.84	HVJ	Vatican City.	Broadcasts daily 5 A. M. to 5:15 A. M.
19.90	T14-NRH	Heredia, Costa Rica.	Sat. 11 A. M. to noon, 4-5 P. M., and 10-11 P. M. Sun. and Mon., 11 A. M. to noon and 4-5 P. M.
20.60	HBJ	Geneva, Switzerland.	Testing.
20.95	G2XM	Sonning-on-Thames, Eng.	Sundays.
23.38	.....	Rabat, Morocco.	Sunday, 7:30 to 9 A. M.
24.60	CT3AQ	Funchel, Madeira.	Tues., Thurs., 4-6:30 P. M., Sun., 10:30 A. M. to noon.
25.20	.....	Pontoise, France.	10:30 A. M. to 1:30 P. M.
25.25	W8XK	Pittsburgh, Pa.	11 A. M. to 9 P. M.
25.34	W9XAA	Chicago, Ill.	Relays WCFL, irregularly.
25.40	12RO	Rome, Italy.	11A.M.to12:30;3to5:30P.M.
25.42	W1XAL	Boston, Mass.	Testing, irregularly.
25.43	VE9GW	Bowmanville, Canada.	Week days, 12 noon to 3 P. M.
25.46	FC1CD	Chi-Hoa, Indo-China	Sat. 10:30A.M.till12:30P.M.
25.50	XDA	Mexico City.	Broadcasts daily, 3 to 4 P. M.
25.53	G5SW	Chelmsford, England.	Daily ex. Sun. 6:30 A. M. to 7:30 A. M. and 12:45 P. M. to 6 P. M.
25.60	VE9JR	Winnipeg, Canada.	Daily excent Sat. and Sun., 11:45 A. M. to 1:30 P. M.
25.68	.....	Pontoise, France.	3 P. M. to 6 P. M. daily.
26.50	.....	Radio Goldberg, Java.	Sun., Tues., Thurs., 5to7 A.M.
28.98	LSX	Buenos Aires, Argentina.	Tests 8 P. M. till 10 P. M.
30.40	EAQ	Madrid, Spain.	Daily 7:30 P. M. to 9 P. M., Sat. 1 to 3 P. M.
31.00	TI4NRH	Heredia, Costa Rica.	Dly.ex.Sat.&Sun.,10-11P.M.
31.25	CT1AA	Lisbon, Portugal.	Tues., Thurs., Fri., 4to7 P. M.
31.26	PCJ	Eindhoven, Holland.	

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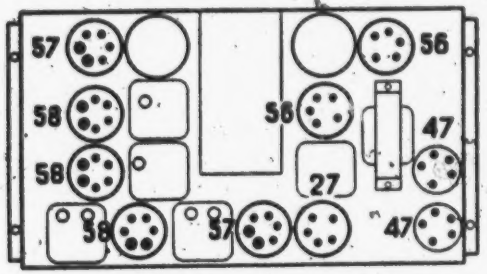
10. It may be noticed occasionally when listening to distant stations that the background noise increases and decreases in a regular fashion, although the program itself does not fluctuate in volume. This is due entirely to fading of the incoming wave. The automatic volume control prevents any change in volume, but as the signal tends to fade out, the sensitivity of the set automatically increases, and the static that is always present becomes greater in proportion to this weaker signal and is, therefore, heard more loudly. This action is particularly noticeable on the short wave ranges.

11. To shut off the set, turn the right hand knob all the way back toward the left until the sharp click of the switch is heard and the pilot light back of the dial goes out.

FRONT OF SET



NOTE: Use an 80 tube in the Power Unit Below.

Fig. 5. Tube Positions.

TUBES USED

The tubes used and their position in the set is shown in Fig. 5.

The '58 type tube is identical in appearance to the '57, the only difference between the two as far as the eye can judge, being in the tube number stamped into the bakelite base. When replacing tubes, it is, therefore, necessary to exercise care so as not to interchange them. While the set will operate with a '57 tube in a '58 socket, or vice versa, performance will be very poor.

SUGGESTIONS

If Volume Is Poor—

1. You may have a defective tube.
2. Your aerial or ground may be poor. Inside aerials very seldom give as much volume as outside ones.
3. You may be shielded by a steel building.
4. You may not have followed instructions. Read the instructions again very carefully, making certain that you have followed them exactly.
5. The line voltage may be low.
6. You may have a '57 tube in the '58 socket.
7. The aerial lead-in connection may be broken.
8. The aerial wire may be disconnected from the set.

If the Set Howls—

1. If howling should occur occasionally when receiving short wave signals, reduce volume and carefully retune to the exact station setting and it will stop.

If Tone Quality Is Poor—

1. The tone control may not be adjusted properly.
2. The station is not properly tuned in.
3. You may have a poor tube.
4. The speaker may be defective.

SHORT WAVE BROADCAST STATIONS

(Courtesy International Short Wave Radio, Klondyke, Ohio)

Since short wave broadcast schedules change at frequent intervals, we cannot guarantee the accuracy of these log tables. For those who are particularly interested in short wave reception we suggest a subscription to a good short wave magazine, such as "International Short Wave Radio," published in Klondyke, Ohio, which has a very complete log that is brought up to date every month.

(Note—The following group of stations broadcast musical programs. Commercial stations are listed separately.)

Wave Length	Call Letters	Location	Operating Schedule (Eastern Standard Time)
14.47	LSY	Buenos Aires, Argentina.	Near 4 P. M. Sundays.
15.93	PLE	Bandoeng, Java.	Tuesdays, 8:40-10:40 A. M.
19.57	W2XAD	Schenectady, N. Y.	3 to 6 P. M. daily, Sat. & Sun. 1 to 6 P. M.
19.68	.....	Pontoise, France.	7 A. M. to 10 A. M. daily.
19.72	W8XK	Pittsburgh, Pa.	6 A. M. to 4 P. M. daily.
19.73	DJB	Zeesen, Germany.	Irregularly Mon., Fri., Sat. and Sun., 8 A. M. to 4 P. M. Usually 8 A. M. to 1 P. M.
19.84	HVJ	Vatican City.	Broadcasts daily 5 A. M. to 5:15 A. M.
19.90	T14-NRH	Heredia, Costa Rica.	Sat. 11 A. M. to noon, 4-5 P. M., and 10-11 P. M. Sun. and Mon., 11 A. M. to noon and 4-5 P. M.
20.60	HBJ	Geneva, Switzerland.	Testing.
20.95	G2XM	Sonning-on-Thames, Eng.	Sundays.
23.38	.....	Rabat, Morocco.	Sunday, 7:30 to 9 A. M.
24.00	CT3AQ	Funchel, Madeira.	Tues., Thurs., 4-6:30 P. M. Sun., 10:30 A. M. to noon.
25.20	.....	Pontoise, France.	10:30 A. M. to 1:30 P. M.
25.25	W8XK	Pittsburgh, Pa.	11 A. M. to 9 P. M.
25.34	W9XAA	Chicago, Ill.	Relays WCFL, irregularly.
25.40	12RO	Rome, Italy.	11 A.M. to 12:30; 3 to 5:30 P.M.
25.42	W1XAL	Boston, Mass.	Testing, irregularly.
25.43	VE9GW	Bowmanville, Canada.	Week days, 12 noon to 3 P. M.
25.46	FC1CD	Chi-Hoa, Indo-China	Sat. 10:30 A.M. till 12:30 P. M.
25.50	XDA	Mexico City.	Broadcasts daily, 3 to 4 P. M.
25.53	G5SW	Chelmsford, England.	Daily ex. Sun. 6:30 A. M. to 7:30 A. M. and 12:45 P. M. to 6 P. M.
25.60	VE9JR	Winnipeg, Canada.	Daily excent Sat. and Sun. 11:45 A. M. to 1:30 P. M.
25.68	.....	Pontoise, France.	3 P. M. to 6 P. M. daily.
26.50	.....	Radio Goldberg, Java.	Sun., Tues., Thurs., 5 to 7 A.M.
28.98	LSX	Buenos Aires, Argentina.	Tests 8 P. M. till 10 P. M.
30.40	EAQ	Madrid, Spain.	Daily 7:30 P. M. to 9 P. M. Sat. 1 to 3 P. M.
31.00	TI4NRH	Heredia, Costa Rica.	Dly. ex. Sat. & Sun., 10-11 P.M.
31.25	CT1AA	Lisbon, Portugal.	Tues., Thurs., Fri., 4 to 7 P. M.
31.26	PCJ	Eindhoven, Holland.	

SHORT WAVE BROADCAST STATIONS

Wave Length	Call Letters	Location	Operating Schedule (Eastern Standard Time)
31.28	VK2ME	Sydney, Australia.	Broadcasts Sundays 1 A. M. to 3 A. M., 5 A. M. to 9 A. M. and 9:30 A. M. to 11:30 A. M.
31.28	W3XAU	Philadelphia, Pa.	3 P. M.-Midnight, except Thurs. and Fri.
31.36	W1XAZ	Springfield, Mass.	6:30 A. M. to 10 P. M.
31.38	DJA	Zeesen, Germany.	8-9 A. M., 10:30-1:30 P. M., and 2-6:30 P. M.
31.40	VK3ME	Melbourne, Australia.	Wed.5-6:30A.M.,Sat.5-7A.M.
31.48	W2XAF	Schenectady, N. Y.	Daily 5 P. M. to 11 P. M.
31.51	OXY	Skamlebaek, Denmark.	Broadcasts 2 to 6:30 P. M.
31.86	PLV	Bandoeng, Java.	Tuesdays, 8:40-10:40 A. M.
32.00	CT3AQ	Funchel, Madeira.	Tue., Thur., 4-6:30 P. M., Sun., 10:30 to noon.
32.26	.....	Rabat, Morocco.	Broadcasts Sun., 3 to 5 P. M.
33.50	TGX	GuatemalaCity,Guatemala.	Sat., 10 P. M. till midnight.
34.68	VE9BY	London, Canada.	Mondays, 3 to 4 P. M.
38.60	HBP	Geneva, Switzerland..	Testing.
39.40	HKF	Bogota, Colombia.	7 P. M. to 11 P. M.
41.00	CM5RY	Matanzas, Cuba.	Sat.; 10:45 to 11:30 P. M.
41.60	EAR58	Tenerife.	Sat. and Sun., 4:30 P. M. to 6 P. M.
42.00	HKT	Manizales, Colombia.	Thur. and Sat., 7-9 P. M. and 11-12 P. M.
42.10	HKK	Cali, Colombia.	Irregular.
42.20	HKN	Medellin, Colombia.	8 P. M. till 10 P. M.
42.90	CT1AA	Lisbon, Portugal.	Fridays, 4 P. M. till 6 P. M.
45.25	HKM	Bogota, Colombia.	Broadcasts 8:30-10:30 P. M. Earlier Sundays.
45.31	PRADO	Riobamba, Ecuador.	Thurs., 9 P. M. till 0 P. M.
46.40	TGW	GuatemalaCity,Guatemala.	9 P. M.-11 P. M.
46.60	REN	Moscow, U. S. S. R.	Moscow, 1 P. M. to 6 P. M,
46.67	VE9BY	London, Canada.	Wed., 8:30-9:30 P. M., Fri., 7:00-7:55 A. M. and Sat., 8-11 P. M.
46.96	W3XL	Boundbrook, N. J.	No regular schedule.
47.00	HCIDR	Quito, Ecuador.	Broadcasts daily, 8 to 10 P. M.
47.30	HSK	Cali, Colombia.	Irregular, near 10 P. M.
48.85	VE9CL	Winnipeg, Canada.	Daily ex. Sun., 6-8:30 P. M.
48.90	HKA	Barranquilla, Colombia.	Broadcasts daily, 8 to 10 P. M.
48.90	FAICD	Chi-Hoa, Indo-China.	6:30 till 10:30 A. M. daily.
48.95	YV11BMO	Maracaibo, Venezuela.	Broadcasts, 8 to 11 P. M.
49.18	W3XAL	Boundbrook, N. J.	Daily, 4 P. M. till midnight.
49.20	JIB	Johannesburg, South Africa.	
49.22	VE9GW	Bowmanville, Canada.	Weekdays, 3-9 P. M., Sun., 11 A. M.-7 P. M.
49.34	W9XAA	Chicago, Ill.	Relays WCFL, Sun., 11 A. M. -9 P. M.; Wed., Sat., 8:30 A. M. to 9 P. M.; Tues. and Thurs., 8:30 A. M. to 8 P. M.

SHORT WAVE BROADCAST STATIONS

Wave Length	Call Letters	Location	Operating Schedule (Eastern Standard Time)
49.40	UOR2	Vienna, Austria.	Tue. and Thurs., 8:30 A. M. to noon, 3-5 P. M.
49.42	VE9CS	Vancouver, B. C.	Sun., 3:30 P. M. to midnight; Fri. at 0 to 1:30 A. M.
49.50	W8XAL	Cincinnati, Ohio.	5 A. M.-9:30 A. M., 12:30-2:30 P. M. and 6 P. M. to 12:30 midnight.
49.50	W3XAU	Philadelphia, Pa.	Thurs. and Fri., 6:15 A. M. to midnight. Other days, 6:15 A. M. to 3 P. M.
49.50	VQ7LO	Nairobi, Kenya, Africa.	Daily, 11 A. M.-3:30 P. M.; Tues., 3 A. M.-4 A. M.; Thur., 8 A. M. to 9 A. M.
49.50	CMCI	Havana, Cuba.	9 P. M.-11 P. M.
49.51	ZL2ZX	Wellington, N. Z.	Mon., Wed., Thurs., Sat., 12:30-4 A. M.
49.59	VE9HX	Halifax, N. S.	Mon., Tues., 6-10 P. M. Other days, 6-7 P. M.
49.80	XEW	Mexico City, Mexico.	Broadcasts, 8-11 P. M., Sun., to 2 A. M.
49.83	W9XF	Chicago, Ill.	2:30-7:00 P. M., 8:30 P. M.-1 A. M.
49.96	VE9DR	Drummondville, Canada.	7 P. M. to 12 midnight.
50.00	HKD	Barranquilla, Colombia.	Daily, 8-10 P. M.
50.00	RW59	Moscow, U. S. S. R.	Thurs. and Sun., 4 to 5 P. M.
50.26	HVJ	Vatican City.	Broadcasts daily, 2-2:15 P. M.; Sun., 5-5:30 A. M.
50.60	HKO	Medellin, Colombia.	Mon., Wed., Fri., 8 to 10 P. M.; Tues., Sat., 6 to 8 P. M.
51.00	HKB	Tunja, Colombia.	Irregular near 10 P. M.
52.50	HCJB	Quito, Ecuador.	Daily except Monday, 7:30 to 10 P. M.
52.70	FIUI	Tananarive, Madagascar.	Sat., Sun., 1-3 P. M. Other days 9:15-11:15 A. M.
62.50	W2XV	Long Island City, N. Y.	Wed. and Fri., 8 till 10 P. M.
62.56	VE9BY	London, Canada.	Saturday, midnight on.
70.1	RV15	Khabarovsk, U. S. S. R.	3 A. M.-9 A. M.
109.60	VE9CI	London, Ontario.	Daily, 9 to 11 P. M.; Sun., 11 A. M.-7 P. M.

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SHORT WAVE COMMERCIAL STATIONS

(Note—These stations are used for relaying telephone messages between countries, ships at sea and shore stations, and aircraft and airport stations. These stations oftimes may be on the air for hours without anything taking place on them, with the exception of the aircraft stations which come on the air and back off again in an instant, or as soon as a message is delivered. They are also sometimes rented to relay radio programs.)

Wave Length	Call Letters	Location	Operating Schedule (Eastern Standard Time)
14.01	WKK	Lawrenceville, N. J.	Phones 8 A. M. till 4 P. M. LSN.
14.19	LSM	Buenos Aires, Arg.	Phones Europe, mornings.
14.24	WKA	Lawrenceville, N. J.	Phones England, 8 A. M. till 4 P. M.
14.27	LSN	Buenos Aires, Arg.	Phones WLO, 8 A. M.-4 P. M.
14.47	LSY	Buenos Aires, Arg.	Phones 10 A. M. to 2 P. M., irregular.
14.55	PMB	Bandoeng, Java.	3:10 A. M.-4:40 A. M. and 8-9:20 A. M., PCK.
14.70	GBA	Rugby, England.	Phones to ships and LSN, irregular.
14.97	DHO	Nauen, Germany.	Phone to LSG., 7 A. M.-11 A. M., irregular.
14.97	OPL	Leopoldsville, Belg. Congo.	Phones ORG mornings.
15.07	LSG	Buenos Aires, Arg.	Phone to FTM, 10:30 A. M.-3:30 P. M.
15.13	WKN	Lawrenceville, N. J.	Phones England, 8 A. M. till 4 P. M.
15.23	EAQ	Madrid, Spain.	Phones to LSY, 7-11 A. M., irregular.
15.24	CEC	Santiago, Chile.	Phones LSR, HJY, near 11 A. M. and 4 P. M.
15.50	FTM	St. Assise, France.	10 A. M.-2 P. M., LSG.
15.57	PPU	Rio de Janeiro, Brazil.	Phone to FTM, 10:30 A. M.-3 P. M.
15.58	DFA	Nauen, Germany.	Phone to XDA, irregularly, 10 A. M.-2 P. M.
15.61	WKF	Lawrenceville, N. J.	Phones England, 8 A. M. till 4 P. M.
15.62	ORG	Brussels, Belgium.	Testing phone, 11 A. M.-11:30 A. M.
15.77	WKW-W2XBJ	Rocky Point, N. Y.	Testing, mornings.
15.82	LSR	Buenos Aires, Arg.	Phones HJY, CEC, 11 A. M. and 4 P. M.
15.93	PLE	Bandoeng, Java.	Tues., Fri., 5:40-10:40 A. M., PCK.
16.06	QCI	Lima, Peru.	Testing with HJY near 2 P. M.
16.11	GBU	Rugby, England.	6 A. M.-2 P. M., WMI.
16.25	HJY	Bogota, Colombia.	Phones CEC, LSR, 11 A. M. and 4 P. M.
16.35	WLA	Lawrenceville, N. J.	Phones England, 8 A. M. till 4 P. M.
16.35	ZLW	Wellington, New Zealand.	Phones VK2ME, irregularly.
16.38	GBS	Rugby, England.	6 A. M.-2 P. M., WND.
16.39	YVQ	Maracay, Venezuela.	Testing near 10 A. M., irreg.
16.44	FTE	St. Assise, France	Phones to FZR, 5 to 9 A. M.

SHORT WAVE COMMERCIAL STATIONS

Wave Length	Call Letters	Location	Operating Schedule (Eastern Standard Time)
16.50	PMC	Bandoeng, Java.	Phones PCV, 3:10-9:20 A. M.
16.54	GBW	Rugby, England.	6 A. M.-2 P. M., WNC.
16.57	GBK	Bodmin, England.	6 A. M.-2 P. M., CGA.
16.67	KQJ	Bolinas, California.	Testing.
16.82	PCV	Kootwijk, Holland.	6 A. M.-9 A. M., Java.
17.05	.....	Ships Majestic (GFWV), Olympic (GLSQ), Belgenland (GMJQ), Homeric (GDLJ), Leviathan (WSBN), Monarch of Bermuda (GTSD), Minnetonka (GKFY), Empress of Britain (GMBJ).	
17.52	WOO	Ocean Gate, N. J.	Phones ships irregularly.
18.06	DAN	Xorden, Germany.	Testing with ships, 9 A. M.-12 noon.
18.44	WLK	Lawrenceville, N. J.	Phones England.
18.56	GBX	Rugby, England.	4 P. M.-11 P. M., VK2ME.
18.71	KKP	Kaunuku, Hawaii.	Phones KWO, 2 P. M.-7 P. M.
18.90	FTK	St. Assise, France.	Phones to FZS, 9 to 10 A. M.
19.03	JIAA	Kemikawa-Cho, Japan.	Experimental, heard early mornings.
19.46	KWO	Dixon, California.	Phones Hawaii, 2-7 P. M.
19.54	KWU	Dixon, California.	Phones Hawaii 2 till 7 P. M.
20.27	WKU-W2XBJ	Rocky Point, N. Y.	Testing in daytime.
20.42	PSS	Rio de Janeiro, Brazil.	Testing with LSN, near 6 P. M.
20.56	WMN	Lawrenceville, N. J.	Phones England, daylight.
20.70	LSN	Buenos Aires, Argentina.	Phones WLO, afternoons.
20.73	WMF	Lawrenceville, N. J.	Phones England, daylight.
20.75	GBW	Rugby, England.	Phones WNC, 6 A. M.-6 P. M.
20.97	.....	.....	Amateur phones heard in daylight.
21.26	.....	.....	.....
21.63	WIY-W2XBJ	Rocky Point, N. Y.	Testing irregular.
21.77	KKW	Dixon, California.	Phones, irregularly.
21.90	KKZ	Bolinas, California.	Testing, irregularly.
22.06	GBB-GBC	Rugby, England.	Phones CGA and ships, afternoons.
22.40	WMA	Lawrenceville, N. J.	Phones England, daylight.
22.68	.....	Ships Majestic (GFWV), Olympic (GLSQ), Belgenland (GMJQ), Homeric (GDLJ), Leviathan (WSBN), Monarch of Bermuda (GTSD), Minnetonka (GKFY), Empress of Britain (GMBJ).	
22.93	JIAA	Kemikawa-Cho, Japan.	Experimental tests, irregularly
23.00	.....	German ships.	11:15 A. M. to 1:30 P. M.
23.36	WOO	Ocean Gate, N. J.	Phone ships, irregularly.
23.38	CNR	Rabat, Morocco	Phones St. Assise, 5-8 A. M.
23.50	IAC	Coltana, Italy.	Testing, irregularly.
24.00	DAN	Xorden, Germany.	Phones ships, noon to 3 P. M.

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SHORT WAVE COMMERCIAL STATIONS

Call Letters	Location	Operating Schedule (Eastern Standard Time)
LM	Bandoeng, Java.	Phones VK2ME near 6:30 A. M.
ZLW	Wellington, New Zealand.	Phone VK2ME, 3 to 8 A. M.
GBU	Rugby, England.	2 P. M.-7 P. M., WMI.
FTN	St. Assise, France.	Testing with USA, irregularly.
GBX	Rugby, England.	4 A. M.-9 A. M.
GBS	Rugby, England.	2 P. M.-7 P. M.
KKQ	Bolinas, California.	Testing, irregularly.
KIO	Kauhuku, Hawaii.	2 to 8 P. M., irregularly.
YVQ	Maracay, Venezuela.	Testing, 5-7 P. M.
PPQ	Rio de Janeiro, Brazil.	Testing near 6 P. M.
XAM	Merida, Yucatan.	Phones XDA, 10 A. M. to 10 P. M., irregularly.
OCI	Lima, Peru.	Phones HJY, evenings.
KWV	Dixon, California.	Phones Hawaii, irregularly.
CEC	Santiago, Chile.	Testing with HJY, evenings.
WOK	Lawrenceville, N. J.	Phones LSN, evenings.
VK2ME	Sydney, Australia.	1 A. M.-7 A. M., GBX.
KEZ	Bolinas, California.	Testing.
PKP	Medan, Sumatra.	Phones Java and VLK, 3 A. M. to 8 A. M.
LSX	Buenos Aires, Argentina.	Testing with U. S. A., 8 to 11 P. M., irregularly.
ORK	Brussells, Belgium.	Phones OPM, 2-4, 9-11 A. M., 3-6 P. M.
PSH	Rio de Janeiro, Brazil.	Testing with W2XBJ, eves.
OPM	Leopoldsville, Belg. Congo.	Phones ORK 2-4, 9-11 A. M., 3-6 P. M.
RT-ZFB	Hamilton, Bermuda.	Phones WNB in daytime.
BU	Rugby, England.	5 P. M.-11 P. M., WMI.
JY	Bogota, Colombia.	Phones OCI irregularly, eves.
SN	Buenos Aires, Argentina.	6 P. M.-6 A. M., WLO.
ON	Lawrenceville, N. J.	Phones England, evenings.
W	Rugby, England.	Phones America, evenings.
KE-VLK	Sydney, Australia.	Phones Java, 4 A. M.-8 A. M.
F	Lawrenceville, N. J.	Phones England, evenings.
F-W2BJ	Rocky Point, N. Y.	Testing irregularly, evenings.
W	Bandoeng, Java.	Phones Australia, 3 A. M.-8 A. M., irregularly.
S-W2XBJ	Rocky Point, N. Y.	Testing irregularly, evenings.
V	Bandoeng, Java.	Phones Australia and Sumatra, 4 A. M.-8 A. M.
A	Drummondville, Canada.	6 P. M.-6 A. M., GBK.
C	Rugby, England.	Phones to ships irregularly.
K	Bodmin, England.	6 P. M.-6 A. M., CGA.
A	Lawrenceville, N. J.	Phones England, evenings.
S	Rugby, England.	6 P. M.-6 A. M., WND.
J	Bolinas, California.	Testing irregularly.
L-W2XBJ	Rocky Point, N. Y.	Testing irregularly, evenings.
F	Wellington, New Zealand.	Phones VLK, 3 A. M.-9 A. M.

SHORT WAVE COMMERCIAL STATIONS

Wave Length	Call Letters	Location	Operating Schedule (Eastern Standard Time)
33.95	.....	Ships Majestic (GFWV), Olympic (GLSQ), Belgenland (GMJQ), Homeric (GDLJ), Leviathan (WSBN), Monarch of Bermuda (GTSD), Minnetonka (GKFY), Empress of Britain (GMBJ).	
35.02	WOO	Ocean Gate, N. J.	Phones ships, irregularly.
36.00	DAN	Norden, Germany.	Phones ships 2-4 A. M. and 3-9 A. M.
36.00	.....	German ships.	2:30 A. M., 4:45 P. M. and 9:30 P. M.
36.65	PSK	Rio de Janeiro, Brazil.	Heard phoning WOK.
37.76	VK2ME	Sydney, Australia.	Tests, 3:00-7:00 A. M., GBX.
38.07	JIAA	Kemikawa-Cho, Japan.	Testing with KEL, irregularly.
38.86	KEE	Bolinas, California.	Testing, irregularly.
39.42	KWX	Dixon, California.	Phones Hawaii, nights.
39.65	KWY	Dixon, California.	Phones Hawaii, nights.
39.89	KDK-KKH	Kauhuku, Hawaii.	Phones KWO, 9 P. M.-2 A. M.
40.54	WEM-W2XBJ	Rocky Point, N. Y.	Testing irregularly, evenings.
42.9	GBS	Rugby, England.	6 P. M.-6 A. M., WND.
43.54	KEQ	Kauhuku, Hawaii.	Phones California, nights.
43.7	KEL	Bolinas, California.	Testing, irregular, JIAA.
44.41	WOA	Lawrenceville, N. J.	Phones VRT, nights.
44.41	WOB	Lawrenceville, N. J.	Phones England, nights.
44.54	WEJ-W2XBJ	Rocky Point, N. Y.	Testing irregularly, evenings.
44.91	DGK	Nauen, Germany.	Testing with WEJ near 9 P. M.
51.00	XDA	Mexico City, Mexico.	Testing with XAM, 10 A. M.-8 P. M., irregularly.
51.09	WNB	Lawrenceville, N. J.	Phones Bermuda, nights.
52.00	XAM	Merida, Yucatan.	Testing with XDA, 10 A. M.-8 P. M., irregularly.
58.30	PMY	Bandoeng, Java.	Phones Australia, near 11 A. M.
59.42	VRT-ZFA	Hamilton, Bermuda.	Phones WNB & GMBJ, nights.
60.26	GBC	Rugby, England.	Phones to ships, irregularly.
62.70	CGA	Drummondville, Canada.	Phones ships, irregularly.
63.13	WOO	Ocean Gate, N. J.	Phones ships, irregularly.
71.82	.....	Ships Majestic (GFVW), Olympic (GLSQ), Belgenland (GMJQ), Homeric (GDLJ), Leviathan (WNBN), Monarch of Bermuda (GTSD), Minnetonka (GKFY), Empress of Britain (GMBJ).	
75-75.8	.....	.....	Amateurs on voice.
118.06	WOX	.....	Bell Telephone Test Station, irregularly.

PLAINTIFF'S EXHIBIT NO. 93, Sheet 24.

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713

SHORT WAVE COMMERCIAL STATIONS

Wave Length	Call Letters	Location	Operating Schedule (Eastern Standard Time)
24.40	PLM	Bandoeng, Java.	Phones VK2ME near 6:30 A. M.
24.40	ZLW	Wellington, New Zealand.	Phone VK2ME, 3 to 8 A. M.
24.41	GBU	Rugby, England.	2 P. M.-7 P. M., WM1.
24.46	FTN	St. Assise, France.	Testing with USA, irregularly.
24.60	GBX	Rugby, England.	4 A. M.-9 A. M.
24.6	GBS	Rugby, England.	2 P. M.-7 P. M.
25.05	KKQ	Bolinas, California.	Testing, irregularly.
25.65	KIO	Kauhuku, Hawaii.	2 to 8 P. M., irregularly.
25.67	YVQ	Maracay, Venezuela.	Testing, 5-7 P. M.
25.75	PPQ	Rio de Janeiro, Brazil.	Testing near 6 P. M.
26.00	XAM	Merida, Yucatan.	Phones XDA, 10 A. M. to 10 P. M. irregularly.
27.35	OCI	Lima, Peru.	Phones HJY, evenings.
27.68	KWV	Dixon, California.	Phones Hawaii, irregularly.
28.12	CEC	Santiago, Chile.	Testing with HJY, evenings.
28.44	WQK	Lawrenceville, N. J.	Phones LSN, evenings.
28.5	VK2ME	Sydney, Australia.	1 A. M.-7 A. M., GBX.
28.80	KEZ	Bolinas, California.	Testing.
28.80	PKP	Medan, Sumatra.	Phones Java and VLK, 3 A. M. to 8 A. M.
28.98	LSX	Buenos Aires, Argentina.	Testing with U. S. A., 8 to 11 P. M., irregularly.
28.99	ORK	Brussells, Belgium.	Phones OPM, 2-4, 9-11 A. M., 3-6 P. M.
29.35	PSH	Rio de Janeiro, Brazil.	Testing with W2XBJ, eves.
29.70	OPM	Leopoldsville, Belg. Congo.	Phones ORK 2-4, 9-11 A. M., 3-6 P. M.
29.80	VRT-ZFB	Hamilton, Bermuda.	Phones WNB in daytime.
30.15	GBU	Rugby, England.	5 P. M.-11 P. M., WM1.
30.20	HJY	Bogota, Colombia.	Phones OCI irregularly, eves.
30.3	LSN	Buenos Aires, Argentina.	6 P. M.-6 A. M., WLO.
30.40	WQN	Lawrenceville, N. J.	Phones England, evenings.
30.60	GCW	Rugby, England.	Phones America, evenings.
30.75	V2KE-VLK	Sydney, Australia.	Phones Java, 4 A. M.-8 A. M.
30.77	WOF	Lawrenceville, N. J.	Phones England, evenings.
31.60	WEF-W2BJ	Rocky Point, N. Y.	Testing irregularly, evenings.
31.63	PLW	Bandoeng, Java.	Phones Australia, 3 A. M.-8 A. M., irregularly.
31.74	WES-W2XBJ	Rocky Point, N. Y.	Testing irregularly, evenings.
31.86	PLV	Bandoeng, Java.	Phones Australia and Sumatra, 4 A. M.-8 A. M.
31.2	CGA	Drummondville, Canada.	6 P. M.-6 A. M., GBK.
32.21	GBC	Rugby, England.	Phones to ships irregularly.
32.4	GBK	Bodmin, England.	6 P. M.-6 A. M., CGA.
32.72	WNA	Lawrenceville, N. J.	Phones England, evenings.
33.25	GBS	Rugby, England.	6 P. M.-6 A. M., WND.
33.27	KEJ	Bolinas, California.	Testing irregularly.
33.52	WEL-W2XBJ	Rocky Point, N. Y.	Testing irregularly, evenings.
33.70	ZLT	Wellington, New Zealand.	Phones VLK, 1 A. M.-9 A. M.

SHORT WAVE COMMERCIAL STATIONS

Wave Length	Call Letters	Location	Operating Schedule (Eastern Standard Time)
33.95	.....	Ships Majestic (GFWV), Olympic (GLSQ), Belgenland (GMJQ), Homeric (GDLJ), Leviathan (WSBN), Monarch of Bermuda (GTSD), Minnetonka (GKFY), Empress of Britain (GMBJ).	
35.02	WOO	Ocean Gate, N. J.	Phones ships, irregularly.
36.00	DAN	Norden, Germany.	Phones ships 2-4 A. M. and 3-9 A. M.
36.00	.....	German ships.	2:30 A. M., 4:45 P. M. and 9:30 P. M.
36.65	PSK	Rio de Janeiro, Brazil.	Heard phoning WOK.
37.76	VK2ME	Sydney, Australia.	Tests, 5:00-7:00 A. M., GBX.
38.07	J1AA	Kemikawa-Cho, Japan.	Testing with KEL, irregularly.
38.86	KEE	Bolinas, California.	Testing, irregularly.
39.42	KWX	Dixon, California.	Phones Hawaii, nights.
39.65	KWY	Dixon, California.	Phones Hawaii, nights.
39.89	KDK-KKH	Kauhuku, Hawaii.	Phones KWO, 9 P. M.-2 A. M.
40.54	WEM-W2XBJ	Rocky Point, N. Y.	Testing irregularly, evenings.
42.9	GBS	Rugby, England.	6 P. M.-6 A. M., WND.
43.54	KEQ	Kauhuku, Hawaii.	Phones California, nights.
43.7	KEL	Bolinas, California.	Testing, irregular, J1AA.
44.41	WOA	Lawrenceville, N. J.	Phones VRT, nights.
44.41	WOB	Lawrenceville, N. J.	Phones England, nights.
44.54	WEJ-W2XBJ	Rocky Point, N. Y.	Testing irregularly, evenings.
44.91	DGK	Nauen, Germany.	Testing with WEJ near 9 P. M.
51.00	XDA	Mexico City, Mexico.	Testing with XAM, 10 A. M.-8 P. M., irregularly.
51.09	WNB	Lawrenceville, N. J.	Phones Bermuda, nights.
52.00	XAM	Merida, Yucatan.	Testing with XDA, 10 A. M.-8 P. M., irregularly.
58.30	PMY	Bandoeng, Java.	Phones Australia, near 11 A. M.
59.42	VRT-ZFA	Hamilton, Bermuda.	Phones WNB & GMBJ, nights.
60.26	GBC	Rugby, England.	Phones to ships, irregularly.
62.70	CGA	Drummondville, Canada.	Phones ships, irregularly.
63.13	WOO	Ocean Gate, N. J.	Phones ships, irregularly.
71.82	.....	Ships Majestic (GFVW), Olympic (GLSQ), Belgenland (GMJQ), Homeric (GDLJ), Leviathan (WNBN), Monarch of Bermuda (GTSD), Minnetonka (GKFY), Empress of Britain (GMBJ).	
75–75.8	.....	.....	Amateurs on voice.
118.06	WOX	.....	Bell Telephone Test Station, irregularly.

POLICE STATIONS

(Note—These stations are used by Police departments to relay messages to police cars that patrol the cities. They come on the air, deliver their message and go right off again. When one is tuned in, just keep the dials at the same place and ofttimes many others may be heard.)

Wave Length	Call Letters and Location
119.71	KGPV, Des Moines, Iowa.
121.5	KGOZ, Cedar Rapids, Iowa; KGPN, Davenport, Iowa; WPDZ, Fort Wayne, Ind.; WPDT, Kokomo, Ind.; WPEC, Memphis, Tenn.; KGPI, Omaha, Neb.; WPDP, Philadelphia, Pa.; KGPW, Salt Lake City, Utah; KGPM, San Jose, Calif.; KGPK, Sioux City, Iowa; WRDQ, Toledo, Ohio.
122.05	WPDO, Akron, Ohio; WPDN, Auburn, N. Y.; WPDV, Charlotte, N. C.; Rochester, N. Y.; WPEA, Syracuse, N. Y.; WPDG, Youngstown, Ohio.
122.35	WRBH, Cleveland, Ohio; KGPZ, Wichita, Kansas.
122.4	WPEF, Bronx, N. Y.; WPEE, Brooklyn, N. Y.; KGPQ, Honolulu, Hawaii; WPDK, Milwaukee, Wis.; WPEG, New York, N. Y.; KGPH, Oklahoma City, Okla.; KGPO, Tulsa, Okla.
123.45	WPDI, Columbus, Ohio.
123.86	KSW, Berkeley, Calif.; WMJ, Buffalo, N. Y.; KGPX, Denver, Colo.; WPDF, Flint, Mich.; WPEB, Grand Rapids, Mich.; WMDZ, Indianapolis, Ind.; KGPE, Kansas City, Mo.; WPDL, Lansing, Mich.; WPDE, Louisville, Ky.; KGPP, Portland, Ore.; WPDH, Richmond, Ind.; KGPG, Vallejo, Calif.
124.17	WPDM, Dayton, Ohio; KGZA, Fresno, Calif.; KGPB, Minneapolis, Minn.; WPDJ, Passaic, N. J.; WPDS, St. Paul, Minn.
124.27	WPDY, Atlanta, Ga.; KGPS, Bakersfield, Calif.; WCK, WPDX, Detroit, Mich.; WRDR, Grosse Pointe Village, Mich.; WMO, Highland Park, Mich.; KGPA, Seattle, Wash.; WPDA, Tulare, Calif.
124.5	WPDW, Washington, D. C.
175.23	WPED, Arlington, Mass.; KGPJ, Beaumont, Texas; WPDB, WPDC, WPDD, Chicago, Illinois; WKDU, Cincinnati, Ohio; KVP, Dallas, Texas; KGPR, Fort Worth, Texas; KGZB, Houston, Texas; KGPL, Los Angeles, Calif.; KGJX, Pasadena, Calif.; WPDU, Pittsburgh, Pa.; KGPC, St. Louis, Mo.; WPEH, Sommerville, Mass.
187 97	WRDU, Brooklyn, N. Y.; WKDT, Detroit, Mich.; WCF, New York, N. Y.
190 6	WRDS, East Lansing, Mich.; WMP, Framingham, Mass.; KGPY, Shreveport, La.
192 55	WEY, Boston, Mass.

AIRCRAFT STATIONS

(Note—This group of stations is used to relay messages to and from airplanes, such as location of a plane, storms signal and similar messages. They come on the air suddenly, deliver a message and go right off again. This list contains only the land stations, although airplanes in flight may be found on the same wavelength.)

Wave Length	Call Letters and Location
53.00	American Airway stations. WSDC, Newark, N. J., WSDM, Albany, N. Y.; WSDO, Buffalo, N. Y.; WSDQ, Cleveland, Ohio. United Airway stations: KEU, Burbank, Calif.; KGT, Fresno, Calif.; Reading, Calif.; KGE, Medford, Ore.; KVO, Portland, Ore.; KZJ, Seattle, Wash.; KFM, Sacramento, Calif.; KQX, Bakersfield, Calif.
53.25	Southern Air Transport Lines. WQDP, Atlanta, Ga.; WSDE, Tuscaloosa, Alabama; WSDB, Jackson, Miss.; KGUK, Shreveport, La.; KGUF, Dallas, Texas; KGUC, Ft. Worth, Texas; KGUL, Abilene, Texas; KGUG, Big Springs, Texas, and KGUA, El Paso, Texas.
53.53	Boeing Air Transport Lines. WQDU, Aurora, Ill.; KQQ, Iowa City, Iowa KQM, Des Moines, Iowa; KMP, Omaha, Nebraska; KRF, Lincoln, Nebraska; KMR, North Platte, Nebraska; KQE, Cheyenne, Wyoming; KQC, Rock Springs, Wyoming; KQD, Salt Lake City, Utah; KKO, Elko, Nevada; KJE, Reno, Nevada; KFO, Oakland, Calif.; KRA, Boise, Idaho, and KDD, Pasco, Washington.
54.00	Transcontinental Air Transport. WAEF, Newark, N. J.; WAEE, Camden, N. J.; WAED, Harrisburg, Pa.; WAEC, Pittsburgh, Pa.; WAEB, Columbus, Ohio; WAEA, Indianapolis, Ind.; KGTR, St. Louis, Mo.; KSY, Tulsa, Okla.; KSW, Amarillo, Texas; KSX, Albuquerque, New Mexico; KGPL, Kingman, Arizona; KGTJ, Las Vegas, Nevada; KSI, Los Angeles, Calif.; KGTD, Wichita, Kansas, and KST, Kansas City, Missouri.
86.00	Same as 53.25 meters.
94.3	United Air Lines stations.
94.52	Same as 53.53 meters.
96.77	Same as 54.00 meters.

IMPORTANT!

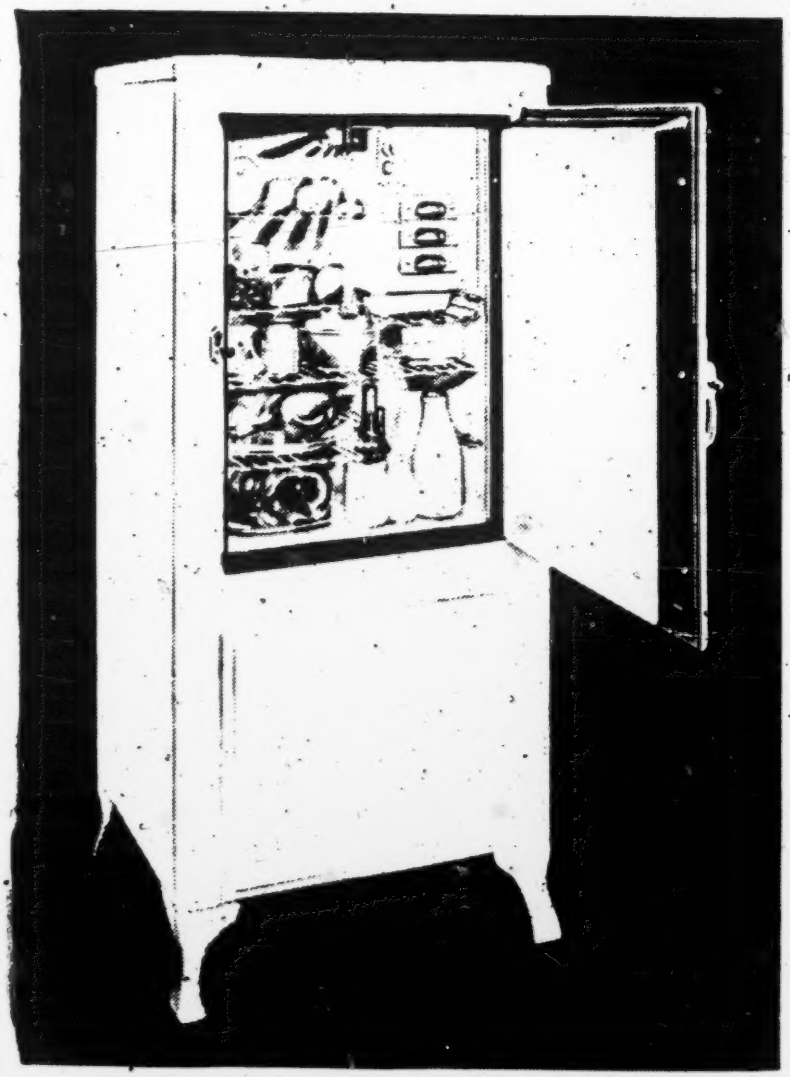
Your Stewart-Warner Radio Receiver is not guaranteed unless you have filled in and mailed the warranty card accompanying each set within ten days after the purchase of the set. Be sure and ask your dealer for this card if it does not accompany the set.

PLAINTIFFS' EXHIBIT NO. 93, Sheet 25.
428-429

PLAINTIFFS' EXHIBIT NO. 93, Sheet 26. 430-431

See the Amazing

STEWART-WARNER
ELECTRIC REFRIGERATORS



before you buy any refrigerator anywhere at any price. Then you will realize that this great organization, world famous for quality manufacturing, has devoted its vast resources to producing the greatest dollar-for-dollar value on the market today.

Sparkling in beauty—brimming with the latest conveniences, these superb refrigerators have every essential that must be in the finest, up-to-date electric refrigerator.

Yet prices are moderate—so much so that you cannot afford to overlook these supreme values! Be sure to see them NOW at your Stewart-Warner dealer's store!

OUTSTANDING FEATURES

Fast-freezing Unit—8-Point Cold Control—Silent Motor—Generous porcelain interior—Automatically lighted food compartment—Massive rubber-valve air-tight sealed door—Two-tone hardware—Heavy insulation.

Four Handsome Models Made to Meet Every Requirement of Home Refrigeration at Sensationally Low Prices!

Ask Your Dealer for a Demonstration

FORM 5619—8-1-32

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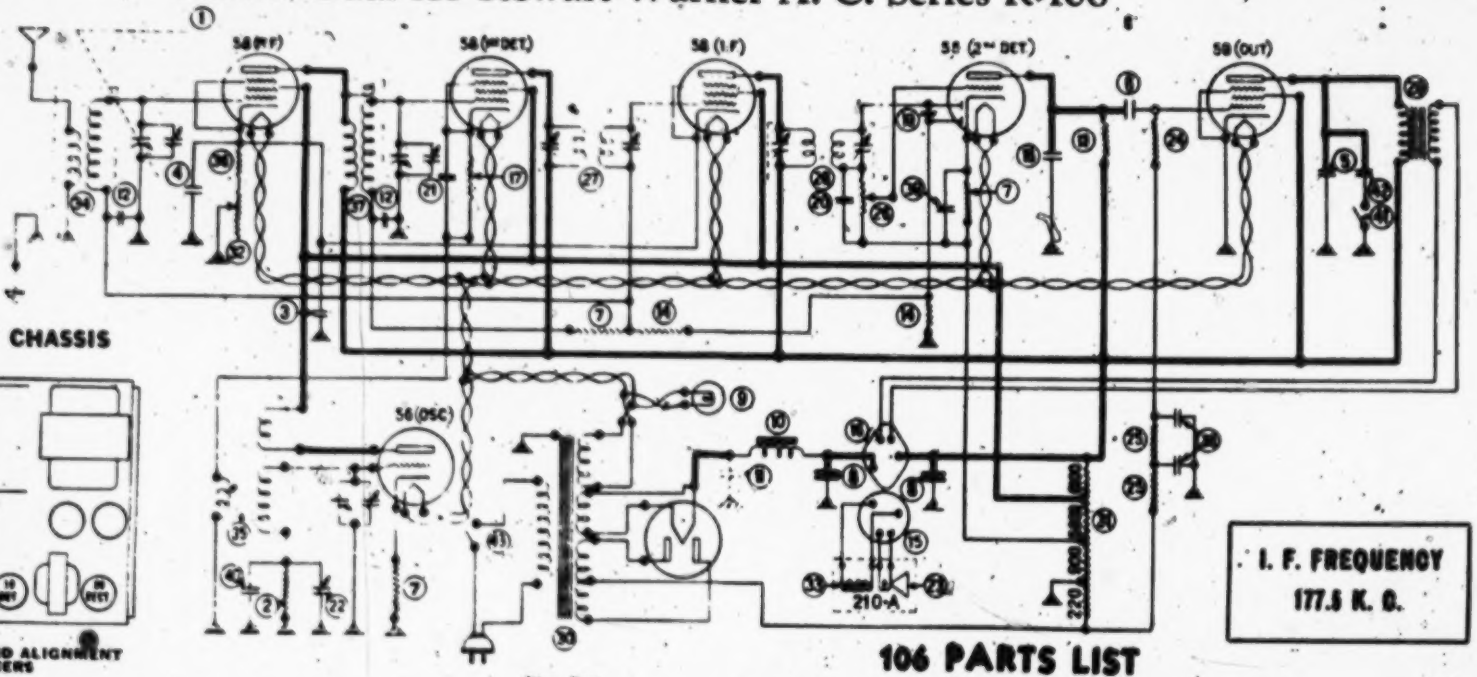
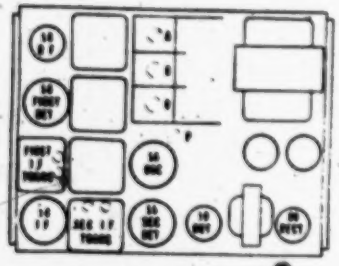
Circuit Data for Stewart-Warner A. C. Series R-106



FRONT OF CHASSIS



TUBE LAYOUT AND ALIGNMENT TRIMMERS

I. F. FREQUENCY
177.5 K. C.

PLAINTIFF'S EXHIBIT NO. 93, Sheet 27

(Circuit Data for Stewart-Warner A.C. Series R-106)

716
432
433

VOLTAGE TABLE

LINE VOLTAGE 115 — VOLUME AND SENSITIVITY CONTROLS FULL ON

Tube Circuit	Type of Tube	Filament Voltage	Plate Voltage*	Screen Grid Voltage	Bias Voltage
56	R. F.	2.29	245	97	3.1
56	Osc.	2.28	97		9.3
56	1st Det.	2.28	245	97	
56	I. F.	2.26	245	97	3.1
55	2nd Det.	2.24	66		7.9
59	Output	2.24	229	245	17.4
80	Rect.	4.78			

All D. C. voltages measured with respect to ground, using high resistance voltmeter of 1000 ohms per volt. Readings will vary, depending upon voltage range of meter, being higher for higher range instruments. This variation is most marked for second detector plate voltages.

*This reading taken between negative end of voltage divider and chassis.

106 PARTS LIST

Illus. No.	Part No.	Description	List Price
1	67248	3 gang tuning condenser	3.50
2	67239	13,000 ohm, ½ w. carbon res.	.25
3	67291	.1 mf., 200 v. tubular cond.	.50
4	67297	.25 mf., 200 v. tubular cond.	.40
5	67298	.01 mf., 600 v. tubular cond.	.30
6	67299	.02 mf., 600 v. tubular cond.	.30
7	67283	2,000 ohm, ½ w. carbon res.	.25
8	67328	8 mf., 160 v. electrolytic cond.	1.75
9	67331	2.5 volt pilot lamp	.25
10	67301	Filter choke coil	2.00
11	67288	8 mf., 300 v. electrolytic cond. (For 25 cycle sets only)	1.00
12	67282	.05 mf., 200 v. tubular cond.	.25
13	67258	100,000 ohm, 1 w. carbon res.	.25
14	67259	1 megohm, ½ w. carbon res.	.25
15	67271	Speaker cable only	.40
	67272	Speaker cable and plug	.60
	81092	Speaker plug only	.20
16	81032	Speaker socket	.20
17	81137	[illegible] ohm, ½ w. carbon res.	.25
18	81138	[illegible].5 mf. platail mica cond.	.25
19	81136	.001 mf. platail mica cond.	.30
20	81137	.00025 mf. platail mica cond.	.30
21	81140	.1 mf., 200 v. tubular cond. & bracket	.25
22	81231	Thrift. pad trimming cond.	.30
23	81276	Diaphragm (R210) and R1.211A)	2.75
24	81279	Diaphragm & shell (R1211)	2.75
25	81301	150,000 ohm, ½ w. carbon res.	.25
26	81302	60,000 ohm, ½ w. carbon res.	.25
27	81101	300,000 ohm volume control	.75
	81310	1st I. F. trans. assembly	2.00
	81309	Double I. F. trim. cond. only	.60
	81231	I. F. transformer coils only	1.00
28	81311	2nd I. F. trans. assembly	2.00
	81309	Double I. F. trim. cond. only	.60
	81231	I. F. transformer coils only	1.00
29	81313	Single speaker output trans.	2.75
	81396	Twin speaker output trans.	2.75
30	81325	115 v., 60 cy. power trans.	8.00
	81371	115 v., 25 cy. power trans.	10.00
	81374	105-230 v., 30-60 cy. power trans.	12.00
31	81380	Voltage divider (4 tap) res.	1.15
32	81321	6,000 ohm sensitivity control & switch	1.50
33	81332	R2104 speaker field coil (2000 ohms)	1.50
	81063	2115 speaker field coil (160 ohms)	1.50
34	81330	R. F. tuning coil	1.50
35	81329	Oscillator tuning coil	1.50
36	81368	200 ohm, ½ w. resistor	.25
37	81330	Plate detector tuning coil	1.50
38	81369	.25 mf., 200 v. shielded, cond. (in case)	1.50
39		.25 mf., 200 v. shielded, cond. (case)	
		.1 mf., 200 v. shielded, cond. (can)	
40	81392	.0075 mf. sensitiv. pad. cond.	.25
41	81616	Tone control switch only	.25
42	81618	.01 mf., 600 v. tubular cond.	.25
43		Power switch (mtd. on 81330)	

PARTS NOT SHOWN IN DIAGRAM

Part No.	Description	List Price
81366	R. F. tube shield shell	.50
81369	R. F. tube shield cover	.50
67961	1st det. & I. F. tube shield	.50
81213	R. F. coil shield (with hole)	.50
67326	R. F. coil shield (plain)	.50
81212	I. F. coil shield	.50
67712	Cisco cond. rubber pad	.25
67711	Cisco cond. rubber washer	.25
67236	Dial drive rubber bushing	.25
81392	Celluloid dial and frame	.50
67209	No. 16 x 3/8" chassis screw	.05
67067	1/4" diam. 1/4 hole washer	.05
81091	No. 0-32 x 1/4", speaker mtg. screw	.05
66725	No. 0-32 thin hex. nut	.05
67933	Escutcheon plate	.50
81226	Escutcheon wood screws ..... per 6	.25
81613	Large knob	.50
81612	Small knob	.50
66961	Felt washer for knobs	.05

SERVICE DATA FOR MODEL 106 CHASSIS

CIRCUIT DESCRIPTION

The Model 106 Stewart-Warner Radio Chassis is a seven tube superheterodyne receiver embodying three important features: (1) Interstation Noise Suppression; (2) "Q" or "Squelch" Circuit; (3) Delayed Automatic Volume Control Action. These desirable features are obtained thru the use of a 55 detector tube which functions as three tubes in one—two diode rectifiers and a triode amplifier. One diode is used for detection, the detected signal obtained in this way being then passed on to the grid of the triode part of the same tube where it is amplified at audio frequencies and fed into the pentode output tube. A constant negative bias is provided on this diode by means of a cathode resistor which prevents detection of signal or noise unless the incoming signal is above a certain minimum value, thus providing the "squelcher" or "Q" circuit. This circuit, in combination with a manually operated sensitivity control (No. 32 on the diagram) makes it possible to eliminate objectionable noise when tuning between stations, resulting in interstation noise suppression.

Delayed A. V. C. is obtained thru the second diode section of the 55 tube, which is coupled to the first by a .001 mfd. condenser. However, this diode plate is about 15 volts negative with respect to the cathode, so that no rectification and consequently no A. V. C. action can take place in this circuit unless the incoming signal builds up to this value, which represents the minimum signal capable of giving full audio output. Consequently no fading will be noticed throughout the range where the A. V. C. has hold. Furthermore, any station not capable of producing full output in the speaker, is not further reduced in volume by the action of the A.V.C. circuit, as is the case in normal A.V.C., so that with delayed A.V.C. weak stations come in with much better volume and the effects of severe fading are greatly minimized.

ALIGNING THE 106 CHASSIS

Alignment can be carried out intelligently only if the service man knows the general layout of the set, and how each circuit is affected during the process of alignment. The simplified top view of the chassis appearing on the other side of this sheet gives the layout of the receiver and locations of the various aligning adjustments. The following brief discussion of what actually happens during alignment should be carefully read, using the sketch as a basis before commencing the actual work.

LOCATION AND FUNCTION OF ALIGNING ADJUSTMENTS

The incoming signal is tuned first by the radio-frequency stage and then fed into the first detector circuit, where it is tuned again to improve selectivity. These circuits are brought into exact alignment by the two trimmer condensers "A" and "B," pointed out in the attached sketch. The tuned oscillator circuit is so designed that it tunes to a frequency exactly 177.5 K.C. higher than the incoming signal. This circuit is kept in exact step by means of two adjustments, the oscillator condenser trimmer "O," and the padding condenser "P," which can be reached thru a small hole in the chassis base just in back of the "O" condenser.

THE "O" TRIMMER IS MAINLY EFFECTIVE AT THE HIGH FREQUENCY END OF THE DIAL, AND THE PADDING CONDENSER "P" AT THE LOW FREQUENCY END. The alignment routine which will be outlined takes this into consideration.

The two intermediate frequency (I.F.) transformers are of the tuned input,—tuned output type and each winding is tuned by a separate trimmer condenser, making a total of four additional adjustments. The first I.F. transformer is in the shield at the right side of the set, while the second I.F. transformer is at the rear of the chassis. The I.F. trimmer adjusting screws can easily be reached thru two small holes at the top of each shield.

Form 5661 Printed in U.S.A.

PRELIMINARY STEPS IN ALIGNING

In aligning the Model 106 it is essential to use a high grade oscillator and sensitive output meter. The I.F. signal fed into the receiver must be very weak or it will cause the A.V.C. circuit to function, making correct alignment impossible. The output meter must be sufficiently sensitive to give a satisfactory reading with this low signal.

Before starting the alignment procedure see that the volume control and inter-station noise suppressor are full on, and the output meter connected either between the pentode plate and ground thru a .25 mfd condenser or across the voice coil, depending upon its sensitivity.

ALIGNING PROCEDURE

With this preliminary discussion clearly in mind, the actual alignment can be started. The following step-by-step routine should be followed for satisfactory results:

1. Set up the oscillator, and tune it to exactly 177.5 K.C. (This frequency can be accurately determined by tuning in a station at either 710 or 1420 K.C. and beating the 4th or 8th harmonic of the oscillator 177.5 K.C. signal against it. To be sure that you have the harmonic of the 177.5 K.C. signal, instead of some other frequency, tune in the other 177.5 harmonics on the broadcast dial. These should come in 177.5 K.C. on either side of the original setting. **Do not use the oscillator calibration curve to determine this intermediate frequency.**)

2. Connect the oscillator output across the grid clip of the first detector tube and ground.

3. Adjust the oscillator output to give about one-half full scale deflection of the output meter.

Adjusting the I. F. Circuits

1. Adjust all four I.F. trimmer condensers, in each case tuning carefully to make sure that maximum deflection is obtained on the output meter.

IT IS VERY IMPORTANT THAT ABSOLUTELY NO INWARD PRESSURE BE APPLIED TO THE ALIGNMENT TOOL, OR THE CONDENSER MAY SPRING BACK TO A DIFFERENT SETTING AS SOON AS THE TOOL IS REMOVED.

2. Go back and repeat all four adjustments since the adjustment of each I.F. trimmer affects the others to a certain extent, thus necessitating readjustment.

Adjusting R. F. and Oscillator Circuits

1. Twist the aerial and ground wires of the set together for their entire length to reduce noise pick-up. Connect the aerial wire to the output of the oscillator and ground both set and oscillator. Adjust the oscillator frequency to 1400 K.C. and carefully tune the receiver to give maximum output. Adjust the oscillator output to produce about one-half full scale deflection of the output meter.

2. Carefully tune the radio frequency stage "A" trimmer till the output meter reading reaches a maximum.

3. Retune the set and adjust the "B" first detector trimmer for maximum output. The oscillator, or "O" trimmer should not be touched unless the set is badly out of calibration at the high frequency end of the dial.

4. Set the oscillator at 600 K.C. and tune the set carefully to this frequency.

5. Adjust the oscillator padding condenser "P" for maximum output, RETUNING THE SET AFTER EACH CHANGE IN ADJUSTMENT. This is important.

6. Turn back the oscillator to 1400 K.C., tune the set to the same frequency, and very carefully readjust the "A" and "B" trimmer condensers to produce maximum output.

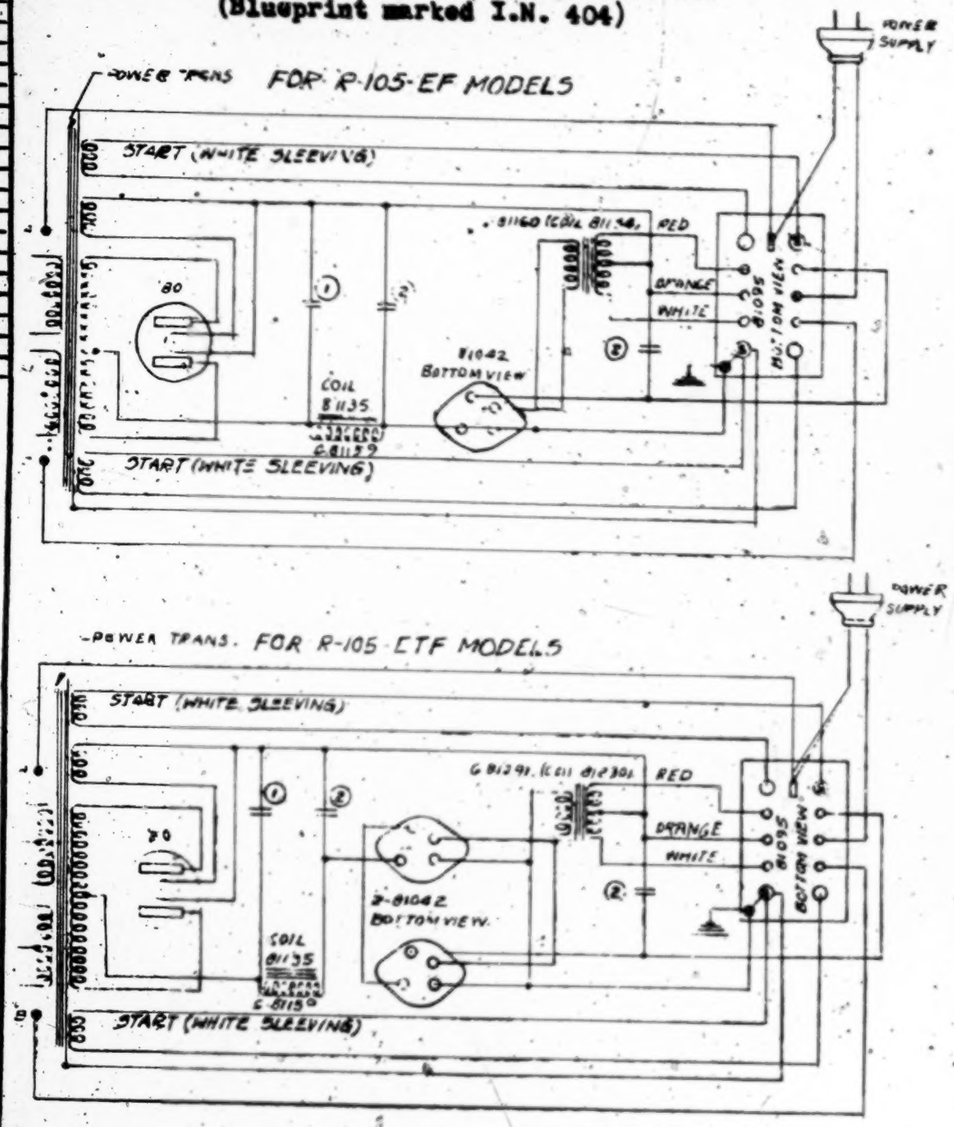
The receiver should now be perfectly aligned.

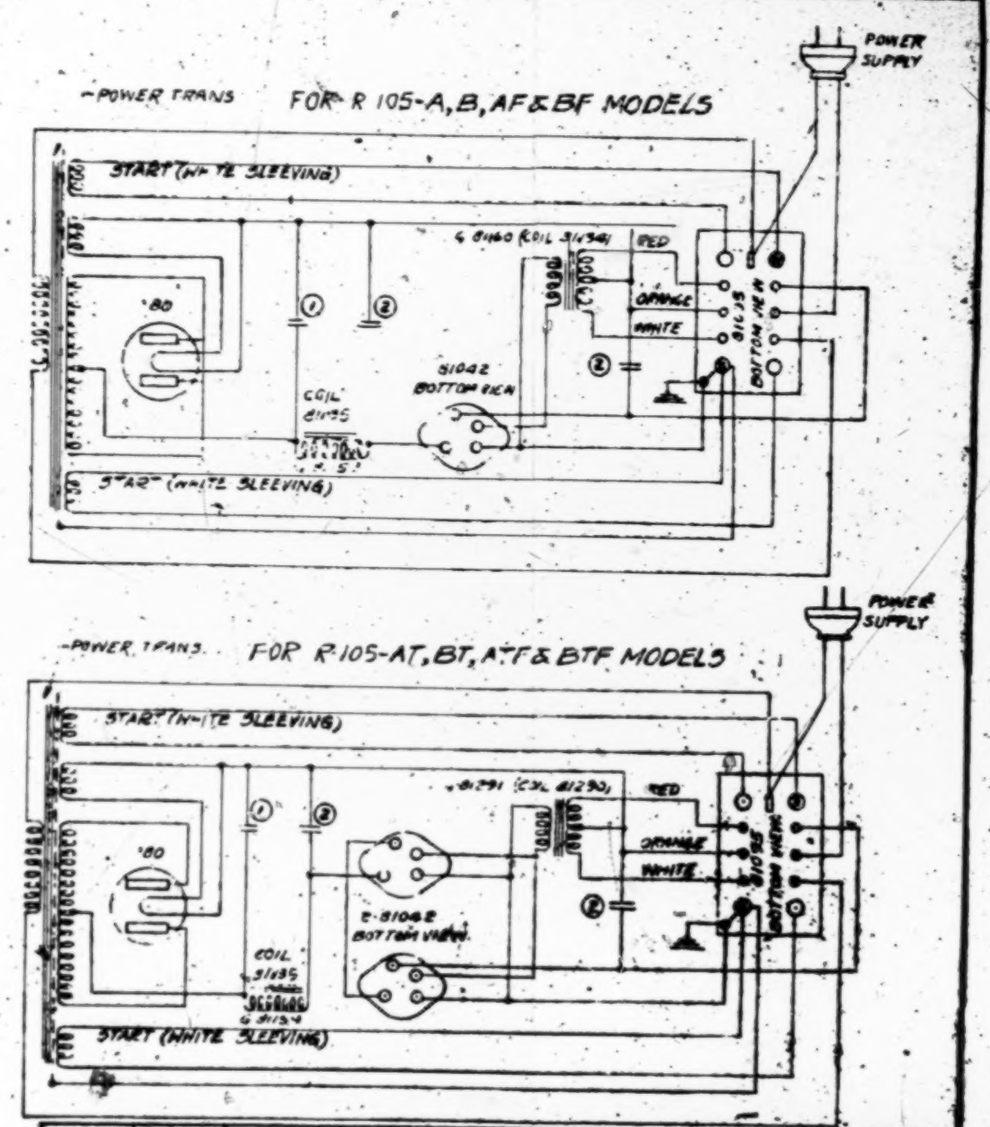
436-437

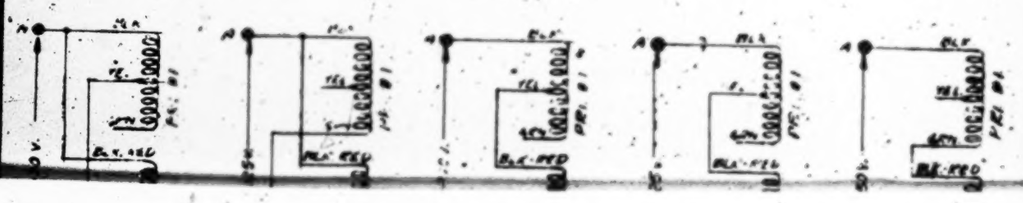
THIS PRINT SUPERSEDES ANY PRINT DATED PRIOR TO

IN-404

PLAINTIFFS' EXHIBIT No. 93, Sheet 29.
(Blueprint marked I.N. 404)

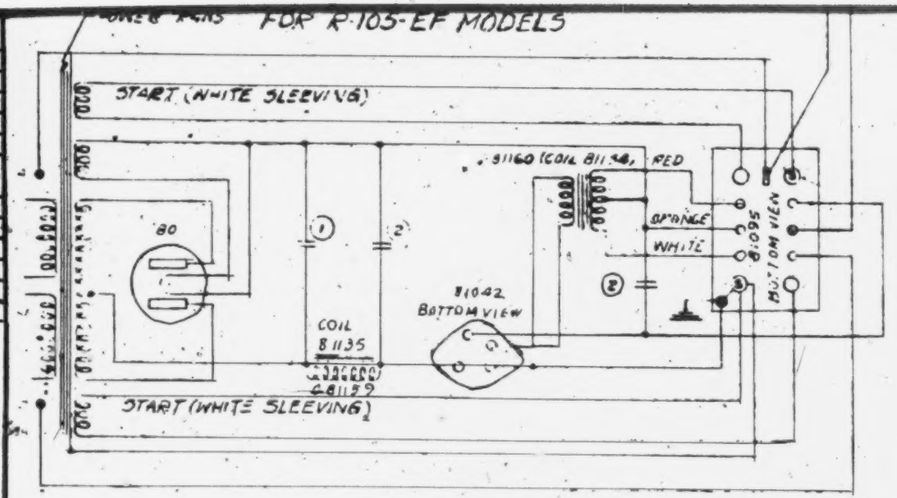




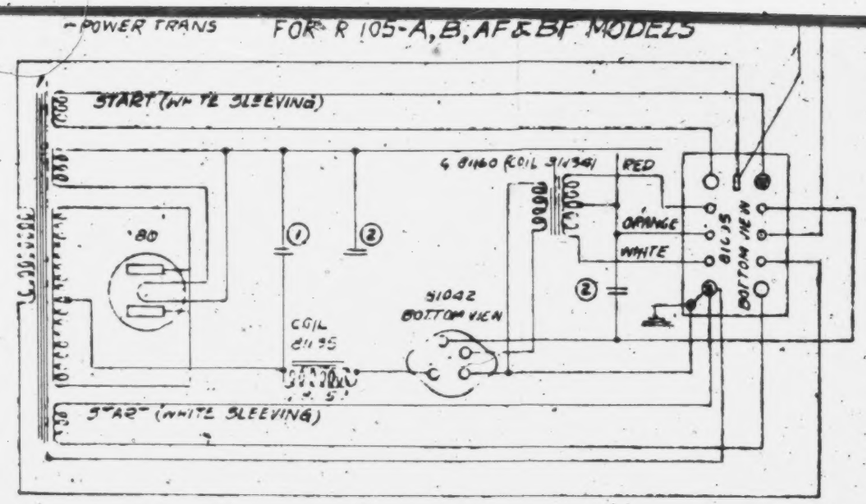


G-81477	60w 115V.	G-81360	G-81372	81347 0-485 V.	67328 0-440V.	MODEL	
G-81365	60w 115V.	G-81358	G-81372	81347 0-485V.	67328 0-440 V.	MODEL	
G-81400	60w 115V.	G-81359	G-81378	81347 0-485V.	67328 0-440V.	MODEL	
G-81364	25w 115V	G-81387	G-81373	81347 10-475-485V.	67328 0-440V.	MODEL	
G-81361	25w 115V.	G-81387	G-81373	81347 10-475-485V.	67328 0-440V.	MODEL	
G-81359	25w 115V	G-81387	G 81373	81347 10-475-485V.	67328 0-440V.	MODEL	
G-81363	60w 115V.	G-81243	G-81238	81347 0-485V.	67328 0-440V.	MODEL	
G-81296	60w 115V	G-81243	G-81238	81347 0-485V.	67328 0-440 V.	MODEL	
G-81250	60w 115V.	G-81243	G-81238	81347 0-485V.	67328 0-440V.	MODEL	

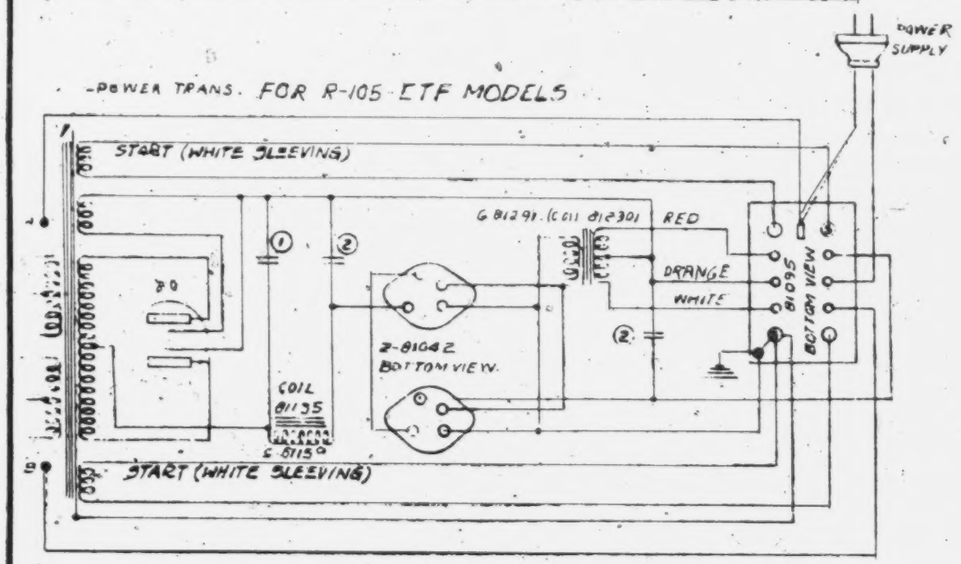
-POWER TRANS FOR R-105-EF MODELS



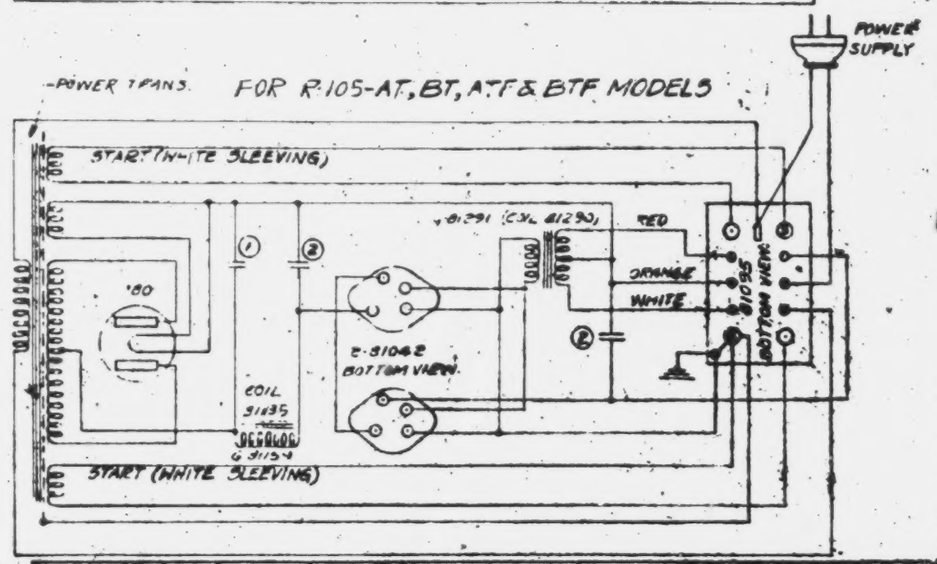
-POWER TRANS FOR R 105-A, B, AF & BF MODELS

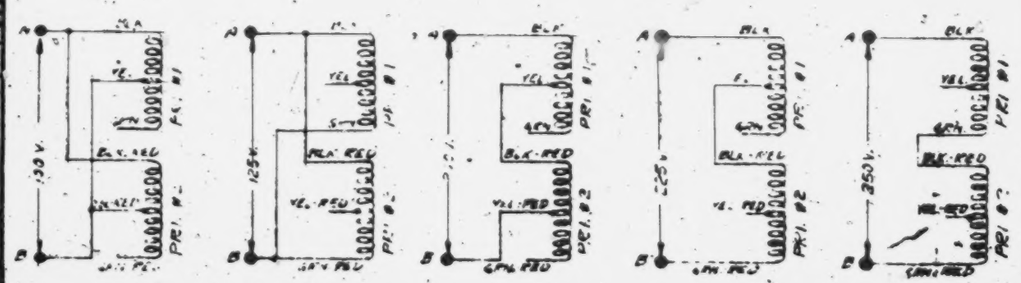


-POWER TRANS. FOR R-105 ETF MODELS



-POWER TRANS. FOR R-105-AT, BT, ATF & BTF MODELS





POWER TRANS. PRIMARY CONNECTIONS (CIRCUIT FOR R105-EF & ETF MODELS.)

G-81477	60w 105-125 VOLT.	G-81388	G-81372	81347 B-485 V.	67328 B-440 V.	MODEL	R105-EF
G-81365	60w 105-125 VOLT.	G-81388	G-81372	81347 B-485 V.	67328 B-440 V.	MODEL	R105-EF
G-81400	60w 105-125 VOLT.	G-81388	G-81372	81347 B-485 V.	67328 B-440 V.	MODEL	R105-EF
G-81364	25w 115 V.	G-81387	G-81373	81367 10-475-485 V.	67328 B-440 V.	MODEL	R105-ETF
G-81361	25w 115 V.	G-81387	G-81373	81367 10-475-485 V.	67328 B-440 V.	MODEL	R105-ETF
G-81359	25w 115 V.	G-81387	G-81373	81367 10-475-485 V.	67328 B-440 V.	MODEL	R105-ETF
G-81363	60w 115 V.	G-81243	G-81238	81347 B-485 V.	67328 B-440 V.	MODEL	R105-AT
G-81296	60w 115 V.	G-81243	G-81238	81347 B-485 V.	67328 B-440 V.	MODEL	R105-AT
G-81250	60w 115 V.	G-81243	G-81238	81347 B-485 V.	67328 B-440 V.	MODEL	R105-AT
CHASSIS	TYPE OF CHASSIS	POWER TRANS.	R. TRANS. COIL	COND.-① 1-USED	-COND.-② 2-USED		

CIRCUIT DIAGRAM, POWER SUPPLY UNIT

8-19-52

IN 484

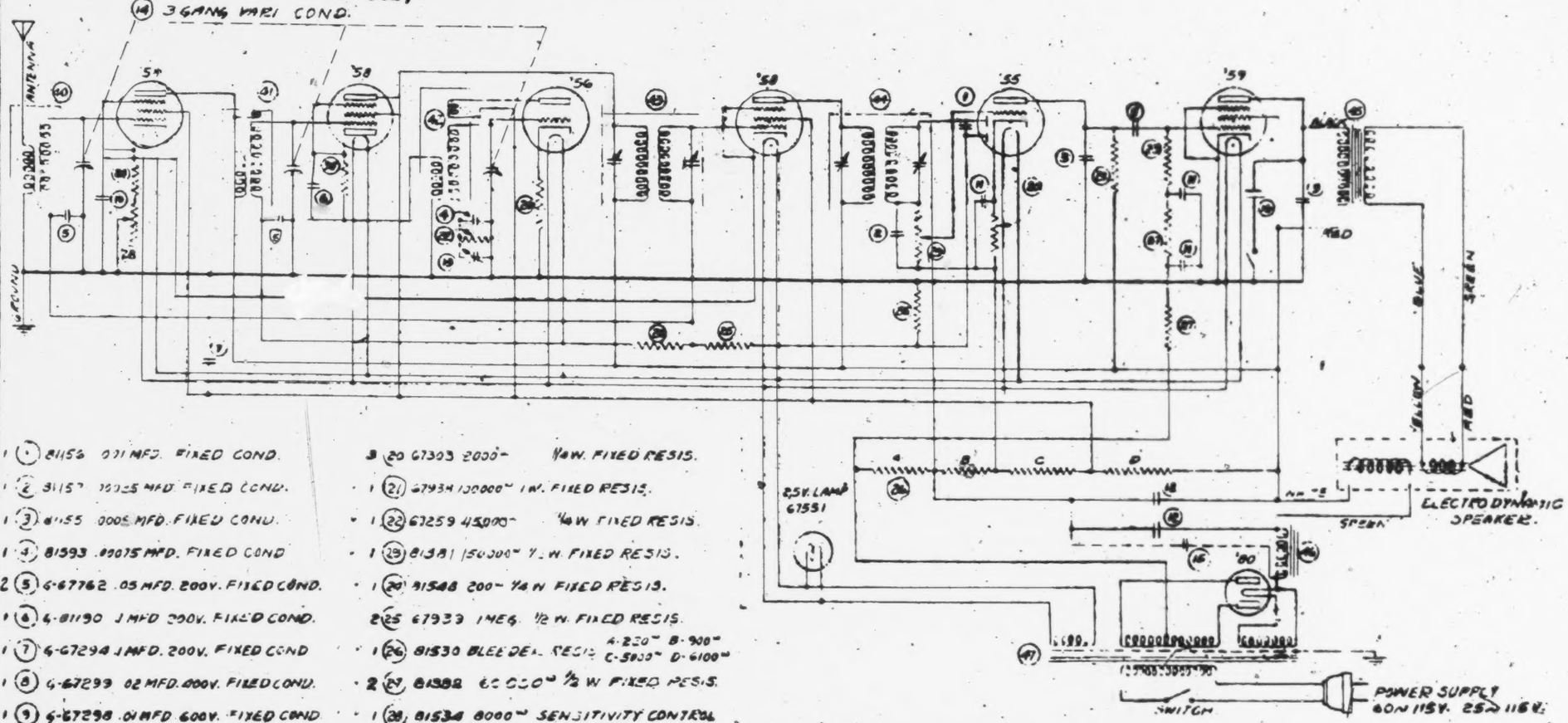
CAUTION

PLAINTIFFS' EXHIBIT No. 93, Sheet 30.
(Blueprint marked I.N. 422)
DEC 12 1936
IN-422

438—439

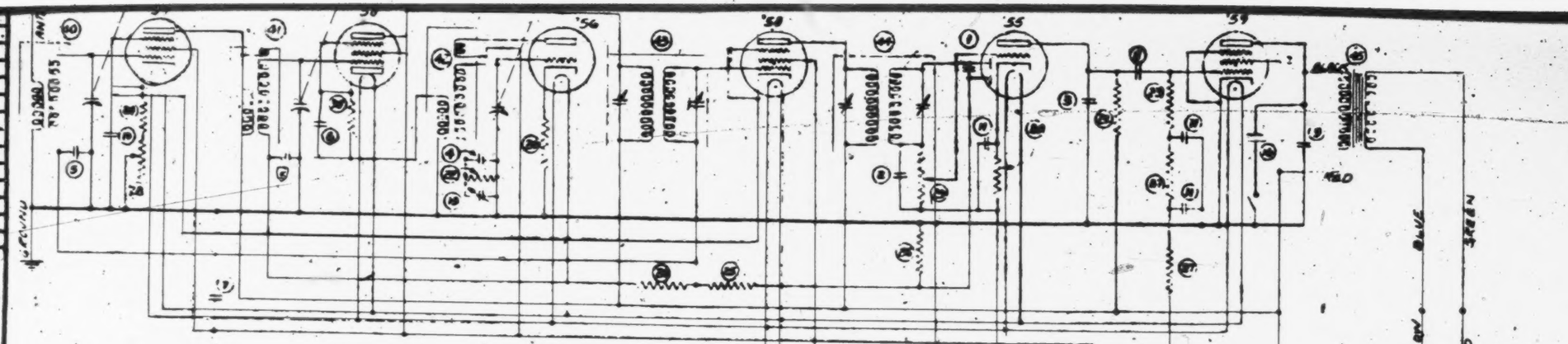
REVISIONS

	MADE	DATE	APP'D
B			
A			



1	(1)	81156 .031 MFD. FIXED COND.	3	(20)	67303 2000~ ½W. FIXED RESIS.
1	(2)	81157 .00025 MFD. FIXED COND.	1	(21)	67934 100000~ 1W. FIXED RESIS.
1	(3)	81155 .0005 MFD. FIXED COND.	1	(22)	67259 45000~ ½W FIXED RESIS.
1	(4)	81593 .00075 MFD. FIXED COND	1	(23)	81581 150000~ ½W. FIXED RESIS.
2	(5)	G-67762 .05 MFD. 200V. FIXED COND.	1	(24)	81548 200~ ¼W FIXED RESIS.
1	(6)	G-81190 .1 MFD 200V. FIXED COND.	2	(25)	67933 1 MEG. ½ W. FIXED RESIS.
1	(7)	G-67294 .1 MFD. 200V. FIXED COND	1	(26)	81530 BLEEDER RESIS. A-230~ B-900~ C-5900~ D-6100~
1	(8)	G-67293 .02 MFD. 400V. FIXED COND.	2	(27)	81582 60,000~ ½ W FIXED RESIS.
1	(9)	G-67298 .01 MFD 600V. FIXED COND	1	(28)	81534 8000~ SENSITIVITY CONTROL
1	(10)	G-67297 .25 MFD. 200V. FIXED COND.	1	(29)	81484 500000~ VOLUME CONTROL
1	(11)	G-81580 2-.25 & 1-1 MFD. 100V. FIXED COND.	1	(30)	81151 4000~ ½ W. FIXED RESIS.
2	(12)	67328 8 MFD. 440V. ELECTRO. COND.			
1	(13)	G-81231 TRIMMER COND.			
1	(14)	67248 VARI TUNING COND.			
1	(15)	67558 8 MFD. 500V ELECTRO. COMB. (25~ ONLY)			
1	(16)	G-81618 .04 MFD. 600V. FIXED COND.			

1	(40)	G-81538 'A' COIL ASSEM
1	(41)	G-81540 'B' COIL ASSEM
1	(42)	G-81539 OSCIL. COIL ASSEM.
1	(43)	G-81510 1ST INTER. TRANS. ASSEM
1	(44)	G-81511 2ND INTER. TRANS. ASSEM.
1	(45)	G-81513 OUTPUT TRANS G-81512 COIL
1	(46)	G-67584 CHOKE 67482 COIL
1	(47)	G-81525 60~ 115V. PWR TRANS. G-81523 COIL G-81574 25~ 115V. PWR. TRANS. G-81568 COIL G-81576 50~ 105 125 210 230-250V. PWR. TRANS. G-81573 COIL.



1	(1) 81156 .031 MFD. FIXED COND.	3	(20) 67303 2000Ω 1/4W. FIXED RESIS.
1	(2) 81157 .00125 MFD. FIXED COND.	1	(21) 67934 100000Ω 1W. FIXED RESIS.
1	(3) 81155 .0005 MFD. FIXED COND.	1	(22) 67259 45000Ω 1/4W FIXED RESIS.
1	(4) 81393 .00075 MFD. FIXED COND	1	(23) 81581 150000Ω 1/2W. FIXED RESIS.
2	(5) 6-67762 .05 MFD. 200V. FIXED COND.	1	(24) 81548 200Ω 1/4W FIXED RESIS.
1	(6) 6-81190 1 MFD 200V. FIXED COND.	2	(25) 67933 1MEG. 1/2 W. FIXED RESIS.
1	(7) 6-67294 1 MFD. 200V. FIXED COND	1	(26) 81530 BLEEDER RESIS. A-220Ω B-900Ω C-5000Ω D-6100Ω
1	(8) 6-67293 .02 MFD. 400V. FIXED COND.	2	(27) 81582 60,000Ω 1/2 W FIXED RESIS.
1	(9) 6-67298 .01 MFD 600V. FIXED COND.	1	(28) 81534 8000Ω SENSITIVITY CONTROL
1	(10) 6-67297 .25 MFD. 200V. FIXED COND.	1	(29) 81484 500000Ω VOLUME CONTROL
1	(11) 6-81580 2-.25 & 1-1 MFD. 100V. FIXED COND.	1	(30) 81151 4000Ω 1/2 W. FIXED RESIS.
2	(12) 67328 8MFD. 440V. ELECTRO. COND.		
1	(13) 6-81231 TRIMMER COND.		
1	(14) 67248 VARI TUNING COND.		
1	(15) 67598 8MFD. 500V ELECTRO. CANS (25~ ONLY)		
1	(16) 6-81618 .04 MFD. 600V. FIXED COND.		

1	(40) 6-81538 "A" COIL ASSEM
1	(41) 6-81550 "B" COIL ASSEM
1	(42) 6-81539 OSCIL. COIL ASSEM.
1	(43) 6-81510 1ST INTER. TRANS. ASSEM
1	(44) 6-81511 2ND INTER. TRANS. ASSEM.
1	(45) 6-81513 OUTPUT TRANS. 6-81512 COIL
1	(46) 6-67584 CHOKE 67482 COIL
1	(47) 6-81525 60W 115V. PWR. TRANS. 6-81523 COIL 6-81574 25W 115V. PWR. TRANS. 6-81368 COIL 6-8574 50W 105 125 210 230-250V. PWR. TRANS. 6-81573 COIL.

POWER TRANS. PRIMARY CONNECTIONS FOR R-106-E MODELS.

CAUTION

CIRCUIT DIAGRAM. R-106 A-B-E

NUMBER IN-422

STEWART-WARNER «» SERIES 60

Chassis 106A, B, & E

INSTRUCTIONS

ANTENNA SYSTEM

Satisfactory radio reception is more dependent upon a proper antenna-ground installation than upon any other factor outside of the set itself. It is the function of the antenna system to collect the minute energy radiated by the broadcast station and carry it to the set. Therefore if you wish to insure yourself consistent and enjoyable reception it is quite important to install a suitable antenna system to pick up and carry the radio signal to your set.

The most satisfactory aerial for any particular location will vary widely depending upon local structural details and sources of interference. As a general rule, a good outside aerial from fifty to seventy-five feet long including lead-in will give best results.

The aerial proper should consist of a length of copper wire insulated at each end with a glazed porcelain or glass insulator. It should be erected as far as possible from buildings, trees, and other obstructions. Do not run it alongside of electric wires, a tin roof, or any metallic structure. Avoid placing the aerial above or below exposed wires installed by the electric light or telephone company.

Where it is not possible to erect an outside aerial, an inside one consisting of sixty feet of insulated wire led around the picture molding of the room makes a fair substitute.

LEAD-IN

The lead-in from the outside aerial should consist of a heavily insulated copper wire. In certain locations where noisy reception is experienced due to interference from electrical machinery in the vicinity of the set, shielded lead-in wire may prove helpful in reducing interference. In extreme cases, special types of aerials and lead-ins designed to balance out interference may be erected. See your local dealer for further information on this point.

INSTALLATION OF GROUND

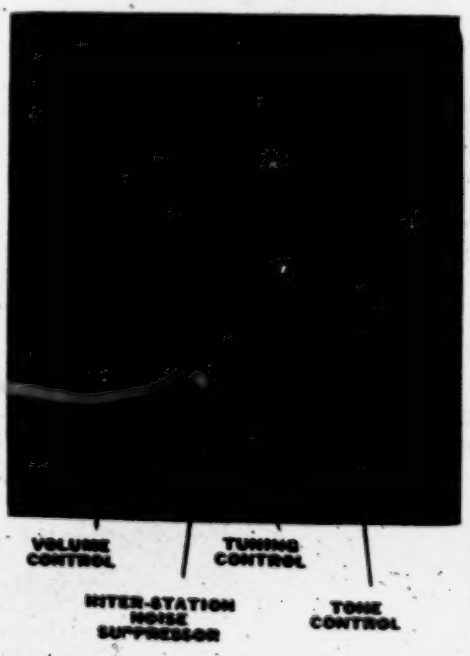
The ground connection is just as important as the aerial.

In a great number of installations a satisfactory ground can be made by connecting to a cold water pipe. This connection should be made by soldering the wire directly to the pipe or by some approved form of ground clamp. The pipe should be thoroughly cleaned and all paint and corrosion removed at the point at which the connection is made. Radiators may also be used for grounds, but do not always give good results.

Very frequently, when the wiring of a home conforms to underwriters' specifications so that all conduit piping is grounded a wire fastened to the metal plate of a base-board outlet makes a satisfactory ground.

HOW TO CONNECT THE SET

Before connecting up the set, be sure that your home is wired for the voltage and current for which the set is designed as indicated on the name plate on the rear of the chassis. If you are in doubt, call up your local power company for the necessary information. Connecting the set to a supply outlet furnishing the wrong type of current will result in improper operation or damage.



Your radio receiver is designed to operate at 115 volts. If the voltage in your home rises above 120 volts, you should purchase a suitable voltage regulator to reduce the line voltage to the proper value so that your radio tubes will give you satisfactory service.

Installation of the set can best be accomplished in the following manner:

1. Remove the packing material holding the tubes in position. Note that some of the tubes have metal caps over which are fitted small clips. **Be sure the metal clips are fitted over the caps, and do not touch the tube shields.**
2. Connect the aerial to the blue wire extending from the back of the chassis. The ground should be connected to the black wire.
3. Plug the extension cord of the set into the most convenient socket.

TUNING INSTRUCTIONS

—Refer to the illustration before attempting to tune the set for the first time.

1. Turn on the set by turning the lower center control knob all the way to the right (clockwise).

2. Turn the left hand (volume) control about half-way to the right.

3. Wait a few seconds for the tubes to warm up. There should be a slight rushing or crackling sound coming from the speaker to indicate the set is ready to be operated.

If the crackling sound is not heard, turn the volume control further toward the right; if it is too loud, turn the volume control to the left.

4. Now turn the center tuning control slowly to bring in stations. You will notice that each station occupies a certain amount of space on the dial in which its volume remains fairly constant. Move the tuning pointer forward and back to determine the width of this space, and then finally set the pointer exactly in the center. This point will give you best tone quality.

5. If too much noise is heard between stations while the set is being tuned, turn the inter-station noise suppressor control (see illustration) back to the left (counter-clockwise direction) until this noise is eliminated.

It will be found that when the inter-station noise suppressor is turned toward the left, volume on received stations will be reduced somewhat, so that it will be necessary to advance the volume control to the right.

In using the inter-station noise suppressor, bear the following in mind:

(a) When tuning the set, the noise suppressor control is normally turned all the way to the right. However, if the noise between stations is too great, it should be turned just far enough to the left until the noise ceases.

(b) The inter-station noise suppressor will not in any way affect noises that come in with the station.

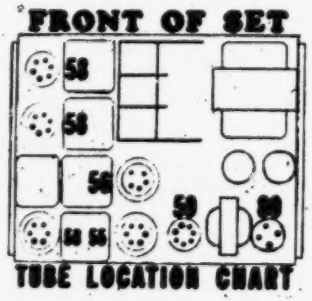
(c) Only the very strongest stations will be brought in with the inter-station noise suppressor control in the left-hand position. As it is progressively rotated toward the right (clockwise direction) it will be found possible to tune in weaker and weaker stations. When tuning for the very weakest stations, turn this control all the way to the right.

(d) Certain stations that happen to come in with a volume about equal to the noise being suppressed will be distorted. To bring in such stations without distortion reduce the noise suppressing action by turning the control to the right until reception clears up.

6. After the desired station is tuned in correctly, the tone control may be adjusted to suit the individual requirements of the listener.

In addition to regulating tone, the tone control has a very important function in reducing static and those interference noises created by the operation of electrical machinery. As it happens, these crackling and frying noises are very largely composed of the higher tones, so that turning the tone control to the right minimizes this interference to a very great extent.

7. The number system on the dial of your radio receiver is conveniently calibrated to indicate broadcasting station frequencies in kilocycles. However, the final zero has been omitted from the dial numbers, so that dial number 110 corresponds to 1100 kilocycles, dial position 55 to 550 kilocycles, and so on.



TUBE LOCATION CHART

8. It may be noticed occasionally when listening to distant stations that the background noise increases and decreases in a regular fashion, although the program itself does not fluctuate in volume. This is due entirely to fading of the incoming wave. The automatic volume control prevents any change in volume, but as the signal tends to fade out, the sensitivity of the set automatically increases, and the static that is always present becomes greater in proportion to this weaker signal so that it is heard more loudly.

TUBES USED

Seven tubes are used. Their type numbers and positions in the set are shown in the tube location diagram.

IMPORTANT!

Your Stewart-Warner Radio Receiver is not guaranteed unless you have filled in and mailed the guarantee registration card accompanying each set within ten days after the purchase of the set. Be sure and ask your dealer for this card if it does not accompany the receiver.

WARRANTY

This is to certify that we, the STEWART-WARNER CORPORATION, Chicago, Illinois, warrant the Stewart-Warner Model R-106 Radio Receiver manufactured by us, to be free from defects in material and workmanship under normal use and service, our obligation under this warranty being limited to repairing or replacing, through an accredited Stewart-Warner distributor, any part or parts of said product that in our judgment show evidence of such defect provided that said product shall have been registered with us at the time of purchase; and provided further, that said product shall be returned to the distributor, transportation prepaid, within 90 days from the date of delivery thereof by the dealer to the purchaser.

This warranty is expressly in lieu of all other warranties, expressed or implied, and of all other obligations on our part, and no representative or other person is authorized or permitted to make any warranty or assume for this corporation any liability not strictly in accordance with the foregoing.

This warranty shall not apply to any product which has been tampered with or altered in any way, or which has been subjected to misuse, negligence or accident, or which has the serial number altered, effaced or removed.

We make no warranty whatsoever in respect to accessories or parts not manufactured by us, as they are usually warranted by their respective manufacturers.

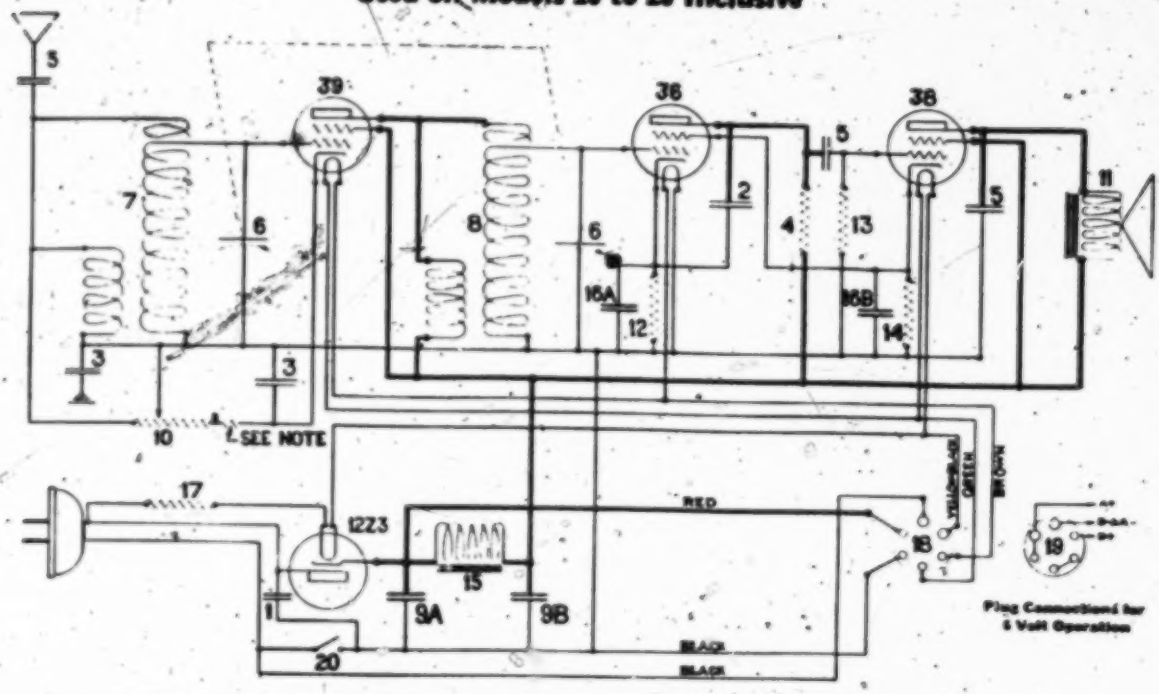
IN WITNESS WHEREOF, this warranty is endorsed by the

Stewart-Warner Corporation, Chicago

Form 5637 Printed in U.S.A.

Circuit Data for Stewart-Warner Chassis Series 108 and 108-X

Used on Models 10 to 20 Inclusive



NOTE: In some receivers, a 140 ohm, ¼ watt carbon resistor, part 81646 is connected in series with the volume control; in other sets this resistor is built into the volume control.

LINE VOLTAGE * 115 VOLTS A. C. **Voltage Table** * VOLUME CONTROL FULL ON

Type of Tube	Tube Current	Filament to Condenser	Plate to Condenser	Screen Grid to Condenser	Cathode to Condenser
39	R. F.	** (See Note)	107	107	1.5
36	Det.	** (See Note)	1.3†	9	1.3
38	Output	** (See Note)	103	107	9
12Z3	Rect.	** (See Note)			122

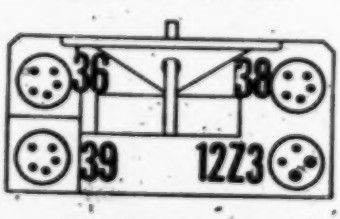
IMPORTANT NOTE

*These voltages will be obtained when the set is operated at 115 volts, 60 cycles A. C. For D. C. operation, voltages will be somewhat lower. All voltage readings have been taken between tube prongs and the variable condenser frame, *not the chassis*. The chassis cannot be used in this receiver as a reference point for voltage readings.

**Filament voltage readings will vary widely, depending upon the resistance of the A. C. voltmeter. With high resistance rectifier type meters, voltage readings will be approximately 6.3 for the detector and amplifier tubes, and 12.6 for the 12Z3 rectifier. With ordinary A. C. Voltmeters, readings will be very much less.

†This reading is obtained with a 30-volt scale, one thousand ohms per volt instrument. Higher resistance meters or higher scale readings will give greater voltage readings.

FRONT OF CHASSIS



TUBE LOCATIONS

PARTS LIST

Diag. No.	Part No.	Description	List Price
1	67298	.01 mfd. 600 V cartridge condenser	$0.30
2	81158	.0001 mfd. mica condenser	.22
3	81630	.1 mfd. 100 V cartridge condenser	.30
4	81611	2.1 meg. ½ W. carbon resistor	.20
	81616	140 ohm ½ W. carbon resistor	.20
5	81657	.003 mfd. mica condenser	.35
6	81662	Variable condenser	3.00
7	81661	Antenna Coil	.90
8	81666	Detector Coil	1.20
9A, 9B	81678	4 mfd. 150 V dry electrolytic condensers in one unit	1.35
10	81679	250,000 ohm volume control and switch	1.50
11	81680	Speaker	5.00
12	81681	20,000 ohm ½ W. carbon resistor	.20
13	81682	1.1 meg. ½ W. carbon resistor	.20
14	81683	1600 ohm ½ W. carbon resistor	.20
15	81691	Filter choke	2.00
16A, 16B	81698	5 mfd. 20 V dry electrolytic condensers in one unit	1.20
17	81735	Power cord assembly	1.30
18	81831	Battery cable socket	.10
19	81861	6 volt battery cable	.90
	81863	12 volt battery cable	
	81865	32 volt battery cable	1.15
20	.....	Switch on back of 81679	

PARTS NOT LISTED ON DIAGRAM

81885	Bronze tuning knob	.35
81886	Bronze volume control knob	.35
81887	Gold tuning knob	.35
81888	Gold volume control knob	.35
81889	Silver tuning knob	.35
81890	Silver volume control knob	.35
81891	Book model knob	.35
81821	Antenna reel	.25
81841	Antenna reel clip	.02
81712	Bronze receiver housing	4.00
81713	Bronze housing back	.60
81731	Gold receiver housing	4.00
81728	Gold housing back	.60
81735	Silver cabinet housing	4.00
81732	Silver housing back	.60
81884	Automobile mounting bracket	.30

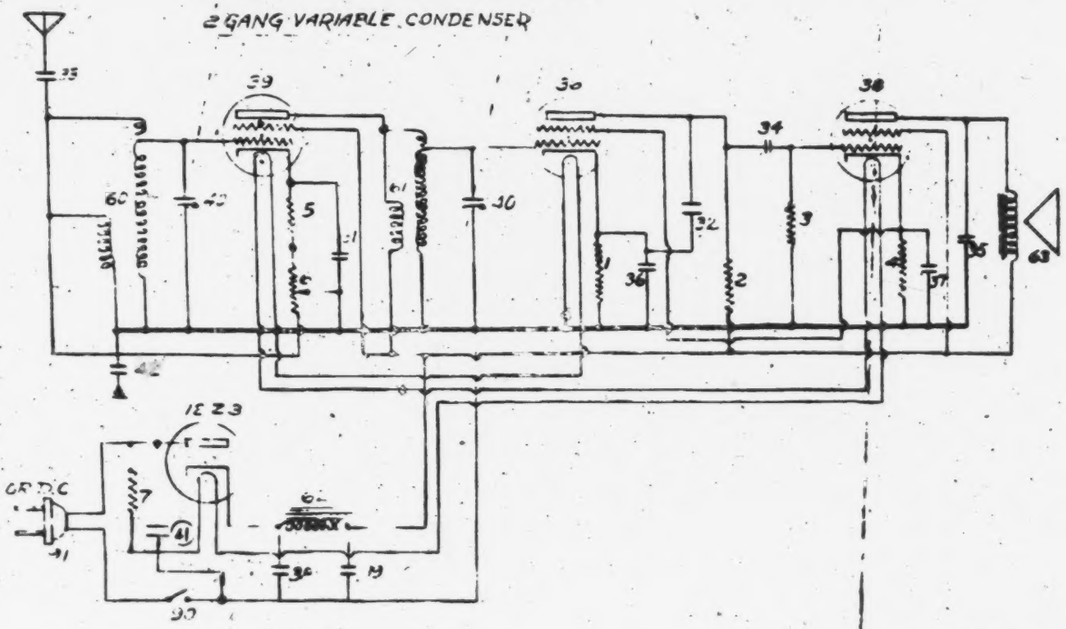
Form 5466 Printed in U. S. A.

REVISIONS			
LTR	WAS	DATE	APP'D

THIS PRINT CONFORMS TO ANY PRINT DATED PRIOR TO

IN426

PLAINTIFFS' EXHIBIT No. 93, Sheet 34.
(Blueprint marked I.N. 426)

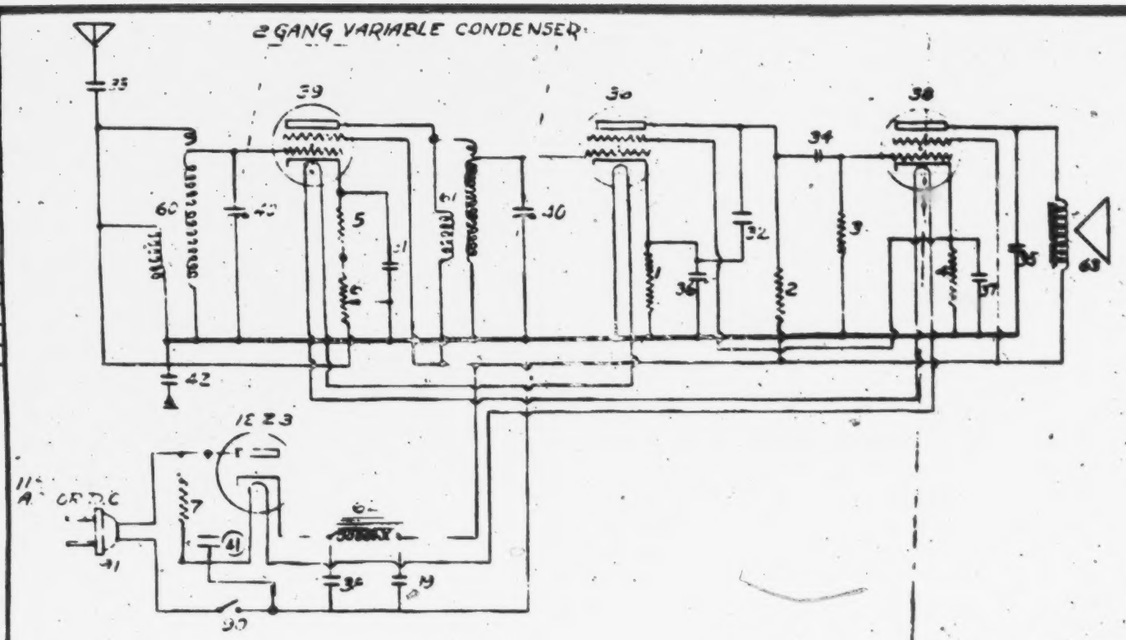


(1)	9163	2300Ω	±5%	¼ WATT	FIXED RESISTOR
(3)	9163	2.1 MEG.	±5%	½ WATT	FIXED RESISTOR
(5)	81662	1.1 MEG.	±5%	½ WATT	FIXED RESISTOR
(7)	9163	1500	±5%	½ WATT	FIXED RESISTOR
(2)	9164	40 Ω	±5%	½ WATT	FIXED RESISTOR
(4)	81662	2 MEG			
(6)					2 WATT
(8)					
(31)	9163	.1 MFD	600 V	FIXED	CONDENSER
(32)	81662	.006	FIXED	MICA	CONDENSER
(33)	81662	.003	FIXED	MICA	CONDENSER
(34)	81662	.003	FIXED	MICA	CONDENSER
(35)	81662	.003	FIXED	MICA	CONDENSER
(36)	81679	5 MFD.	20V	ELECTROLYTIC CONDENSER	SAME UNIT
(37)	81679	5 MFD	20V	ELECTROLYTIC CONDENSER	
(38)	81679	4 MFD	150V	ELECTROLYTIC CONDENSER	SAME UNIT
(39)	81679	4 MFD	150V	ELECTROLYTIC CONDENSER	

40 81662 VARIABLE CONDENSER
(41) 67298 .01 MFD. 600V FIXED CONDENSER
(42) 67628 .01 MFD. 600 V. FIXED CONDENSER
(60) 81664 ANTENNA COIL ASSEMBLY
(61) 81660 DETECTOR COIL ASSEMBLY
(62) 81694 FILTER CHOKE ASSEMBLY
(63) 81680 MAGNETIC SPEAKER
(90) [illegible] SWITCH ON BACK OF 81679
(91) 81695 POWER CORD ASSEMBLY

CIRCUIT DIAGRAM FOR R-149

CAUTION



(1)	81	2500	¼ WATT	FIXED	RESISTOR
(3)	81	0.1 MEG	¼ WATT	FIXED	RESISTOR
(5)	81682	1.1 MEG	¼ WATT	FIXED	RESISTOR
(7)	8167	1500	¼ WATT	FIXED	RESISTOR
(8)	8167	40 M	¼ WATT	FIXED	RESISTOR
(9)	81				MEG
(10)					¼ WATT

(31)	8163	.1 MFD.	400 V	FIXED MICA CONDENSER
(32)	8165	.002	FIXED	MICA CONDENSER
(33)	81657	.003	FIXED	MICA CONDENSER
(34)	81657	.003	FIXED	MICA CONDENSER
(35)	81657	.003	FIXED	MICA CONDENSER
(36)	81679	5 MFD.	20V	ELECTROLYTIC CONDENSER } SAME UNIT
(37)	81679	5 MFD.	20V	ELECTROLYTIC CONDENSER }
(38)	8167	4 MFD	180V	ELECTROLYTIC CONDENSER } SAME UNIT
(39)	81679	4 MFD	180V	ELECTROLYTIC CONDENSER }

40	81662	VARIABLE CONDENSER
(41)	67298	.01 MFD. 600V. FIXED CONDENSER
(42)	67298	.01 MFD. 600 V. FIXED CONDENSER
(60)	81664	ANTENNA COIL ASSEMBLY
(61)	81660	DETECTOR COIL ASSEMBLY
(62)	81694	FILTER CHOKE ASSEMBLY
(63)	81680	MAGNETIC SPEAKER
(90)		SWITCH ON BACK OF 81679
(91)	81695	POWER CORD ASSEMBLY

CAUTION

CIRCUIT DIAGRAM FOR R-108

DEC 23, 1932

IN 426

STROMBERG-CARLSON CORPORATION, CHICAGO, U.S.A.

STEWART-WARNER
CHASSIS MODEL 108
INSTRUCTIONS

The Stewart-Warner Model 108 Compact Radio Receiver is made to operate on either alternating current (A.C.) at any frequency between 25 and 70 cycles or direct current (D.C.) at any voltage between 100 and 135.

PREPARING THE SET FOR OPERATION

To put the set into operation, stretch out the antenna wire to its full length.

This Stewart-Warner Radio Receiver is equipped with the latest exclusive "Aerial Reel." This reel is clipped to the bottom of the cabinet, out of the way when the set is to be moved, yet instantly ready for use. To put the aerial into use, merely pull the reel outward, which releases it from its retaining clip, and unwind the aerial by rolling it out on the floor, or letting it hang out of a convenient window. The reel is tied to the aerial wire so it cannot be lost, and is always ready to be wound up again and clipped back into place.

Occasionally good results will be obtained if the aerial wire is connected to a radiator or water pipe. Greater volume and more distant stations, however, will be obtained if the set is connected to an outside aerial.

This is particularly true if the receiver is to be used in a modern steel building. If the aerial is too long, however, it may be difficult to separate powerful local stations. The remedy is to shorten the aerial.

It is very important that the self-contained antenna wire is stretched out as far from the set as possible. If a coil of it is left next to the set, it may result in lessened volume accompanied by squealing or howling.

TUNING INSTRUCTIONS

Plug the line cord into any convenient 110 volt electric outlet and turn the volume control knob of the set three-fourths of the way to the right. This turns on the set and sets the volume control near maximum. After waiting a few seconds until the tubes warm up, you should hear a slight crackling sound coming from the set. **If the house lighting supply is D.C., you may not hear this crackling sound until you reverse the plug in its outlet.**

Turn the tuning knob very slowly throughout its entire range to pick up stations. If a station signal is accompanied by whistling or distortion, turn back the volume control until reception clears up.

When tuning the set for a weak station with the volume control well advanced, you will notice that the signal may start coming in as a high-pitched whistle which drops in pitch and then rises again as you continue tuning. To bring in such stations correctly, adjust the tuning control exactly midway between the two whistles and very slowly turn back the volume control until the station comes in clearly. Now go back and re-adjust both tuning and volume controls carefully once or twice until you get loudest reception without distortion. **This repeated adjustment is absolutely necessary for very weak stations.**

To shut off the set, turn the volume control all the way to the left (counter-clockwise) until you hear the switch snap "off."

(OVER)

GENERAL INSTRUCTIONS

If the volume control is advanced too far the set may oscillate (whistle on stations) or overload, which is indicated by distortion and poor volume. Turning back the volume control will clear up reception in such cases.

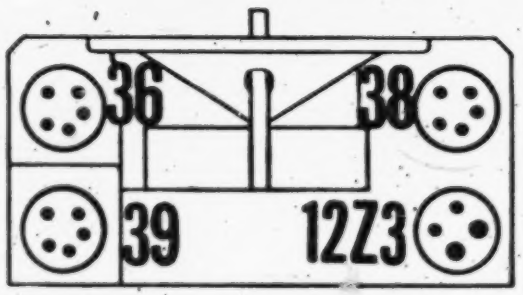
If the antenna is run too close to the set or not completely uncoiled near the set, it may oscillate (whistle on stations). In that event, stretch out the aerial wire so that it is not coiled up near to or about the set.

The Model 108 Radio Receiver Chassis uses the Stewart-Warner patented "Heat Take-Off Cord" which greatly reduces the heat inside the receiver ensuring long service-free operation.

This Heat Take-Off Cord dissipates the heat outside the receiver and consequently the cord becomes warm in use when the set is being used.

Do not reduce the length of or cut into the 110 volt cord of the set or you may burn out the tubes. If it is necessary to increase the length of the cord to reach a convenient socket, it is best to use a separate extension cord fitted with a plug and socket, since it is very difficult to make a good permanent connection to the extra resistance wire contained in the 110 volt cord.

FRONT OF CHASSIS



TUBE LOCATIONS

TUBES

The Model 108 uses four tubes of the following types: one type 36, one type 38, one type 39, and one type 12Z3 or 14Z3. The correct placement of these tubes in their sockets is shown in the diagram on this sheet.

When inserting the 12Z3 rectifier tube in its socket do not use too much force. If the tube does not slip in easily, you are probably trying to insert it incorrectly. Rotate the tube until the four prongs plug into the socket without being forced.

WARRANTY

This is to certify that we, the STEWART-WARNER CORPORATION, Chicago, Illinois, warrant the Stewart-Warner Model R-108 Radio Receiver manufactured by us, to be free from defects in material and workmanship under normal use and service, our obligation under this warranty being limited to repairing or replacing, through an accredited Stewart-Warner distributor, any part or parts of said product that in our judgment show evidence of such defect provided that said product shall be returned to the distributor, transportation prepaid, within 90 days from the date of delivery thereof by the dealer to the purchaser.

This warranty is expressly in lieu of all other warranties, expressed or implied, and of all other obligations on our part, and no representative or other person is authorized or permitted to make any warranty or assume for this corporation any liability not strictly in accordance with the foregoing.

This warranty shall not apply to any product which has been tampered with or altered in any way, or which has been subjected to misuse, negligence or accident, or which has the serial number altered, effaced or removed.

We make no warranty whatsoever in respect to accessories or parts not manufactured by us, as they are usually warranted by their respective manufacturers.

IN WITNESS WHEREOF, this warranty is endorsed by the

Form 5649 Printed in U.S.A. **Stewart-Warner Corporation, Chicago.**

STEWART-WARNER

CHASSIS MODEL 108X

INSTRUCTIONS

The Stewart-Warner Model 108X Compact Radio Receiver is made to operate on either alternating current (A.C.) at any frequency between 25 and 70 cycles, direct current (D.C.) at any voltage between 100 and 135, and automobile, motor-boat, Pullman, and farm-lighting batteries of 6, 12 or 32 volts. For battery operation, a special socket is provided at the back of the set, into which is plugged a special battery cable. This special battery cable can be purchased from your dealer.

When purchasing one of these battery cables, be sure to specify whether it is to be used on six, twelve, or thirty-two volts. Different cables must be used for each different value of battery voltage—the cables are not interchangeable.

Full directions for the connection of these cables both to the main battery supply and to the 135 volt B battery that is also required are given with each cable.

PREPARING THE SET FOR OPERATION

To put the set into operation, stretch out the antenna wire to its full length.

This Stewart-Warner Radio Receiver is equipped with the latest exclusive "Aerial Reel." This reel is clipped to the bottom of the cabinet, out of the way when the set is to be moved, yet instantly ready for use. To put the aerial into use, merely pull the reel outward, which releases it from its retaining clip, and unwind the aerial by rolling it out on the floor, or letting it hang out of a convenient window. The reel is tied to the aerial wire so it cannot be lost, and is always ready to be wound up again and clipped back into place.

Occasionally good results will be obtained if the aerial wire is connected to a radiator or water pipe. Greater volume and more distant stations, however, will be obtained if the set is connected to an outside aerial.

This is particularly true if the receiver is to be used in a modern steel building. If the aerial is too long, however, it may be difficult to separate powerful local stations. The remedy is to shorten the aerial.

It is very important that the self-contained antenna wire is stretched out as far from the set as possible. If a coil of it is left next to the set, it may result in lessened volume accompanied by squealing or howling.

TUNING INSTRUCTIONS

For operation on 100 to 135 volts, no special battery cable is required; just plug the line cord, which is an integral part of each set, into a convenient outlet. For battery operation, use the special cable intended for that voltage. After connecting the line cord or special cable, turn the volume control knob of the set three-fourths of the way to the right. This turns on the set and sets the volume control near maximum. After waiting a few seconds until the tubes warm up, you should hear a slight crackling sound coming from the set. **If the set is connected to a D.C. house lighting supply, you may not hear this crackling sound until you reverse the plug in its outlet.**

Turn the tuning knob very slowly throughout its entire range to pick up stations. If a station signal is accompanied by whistling or distortion, turn back the volume control until reception clears up.

When tuning the set for a weak station with the volume control well advanced, you will notice that the signal may start coming in as a high pitched whistle which drops in pitch and then rises again as you continue tuning. To bring in such stations correctly, adjust the tuning control exactly midway between the two whistles and very slowly turn back the volume control until the station comes in clearly. Now go back and re-adjust both tuning and volume controls carefully once or twice until you get loudest reception without distortion. This repeated adjustment is absolutely necessary for very weak stations.

To shut off the set, turn the volume control all the way to the left (counter-clockwise) until you hear the switch snap "off."

GENERAL INSTRUCTIONS

If the volume control is advanced too far the set may oscillate (whistle on stations) or overload, which is indicated by distortion and poor volume. Turning back the volume control will clear up reception in such cases.

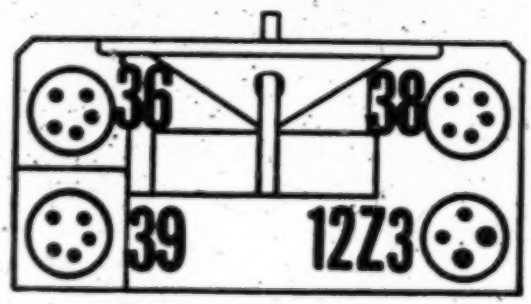
If the antenna is run too close to the set or not completely uncoiled near the set, it may oscillate (whistle on stations). In that event, stretch out the aerial wire so that it is not coiled up near to or about the set.

The Model 108X Radio Receiver Chassis uses the Stewart-Warner patented "Heat Take-Off Cord" which greatly reduces the heat inside the receiver ensuring long service-free operation.

This Heat Take-Off Cord dissipates the heat outside the receiver and consequently the cord becomes warm in use when the set is being used.

Do not reduce the length of or cut into the 110 volt cord of the set or you may burn out the tubes. If it is necessary to increase the length of the cord to reach a convenient socket, it is best to use a separate extension cord fitted with a plug and socket, since it is very difficult to make a good permanent connection to the extra resistance wire contained in the 110 volt cord.

FRONT OF CHASSIS



TUBE LOCATIONS

TUBES

The Model 108X uses four tubes of the following types: one type 36, one type 38, one type 39, and one type 12Z3 or 14Z3. The correct placement of these tubes in their sockets is shown in the diagram on this sheet.

When inserting the 12Z3 rectifier tube in its socket do not use too much force. If the tube does not slip in easily, you are probably trying to insert it incorrectly. Rotate the tube until the four prongs plug into the socket without being forced.

WARRANTY

This is to certify that we, the STEWART-WARNER CORPORATION, Chicago, Illinois, warrant the Stewart-Warner Model R108X Radio Receiver manufactured by us, to be free from defects in material and workmanship under normal use and service, our obligation under this warranty being limited to repairing or replacing, through an accredited Stewart-Warner distributor, any part or parts of said product that in our judgment show evidence of such defect provided that said product shall be returned to the distributor, transportation prepaid, within 90 days from the date of delivery thereof by the dealer to the purchaser.

This warranty is expressly in lieu of all other warranties, expressed or implied, and of all other obligations on our part, and no representative or other person is authorized or permitted to make any warranty or assume for this corporation any liability not strictly in accordance with the foregoing.

This warranty shall not apply to any product which has been tampered with or altered in any way, or which has been subjected to misuse, negligence or accident, or which has the serial number altered, effaced or removed.

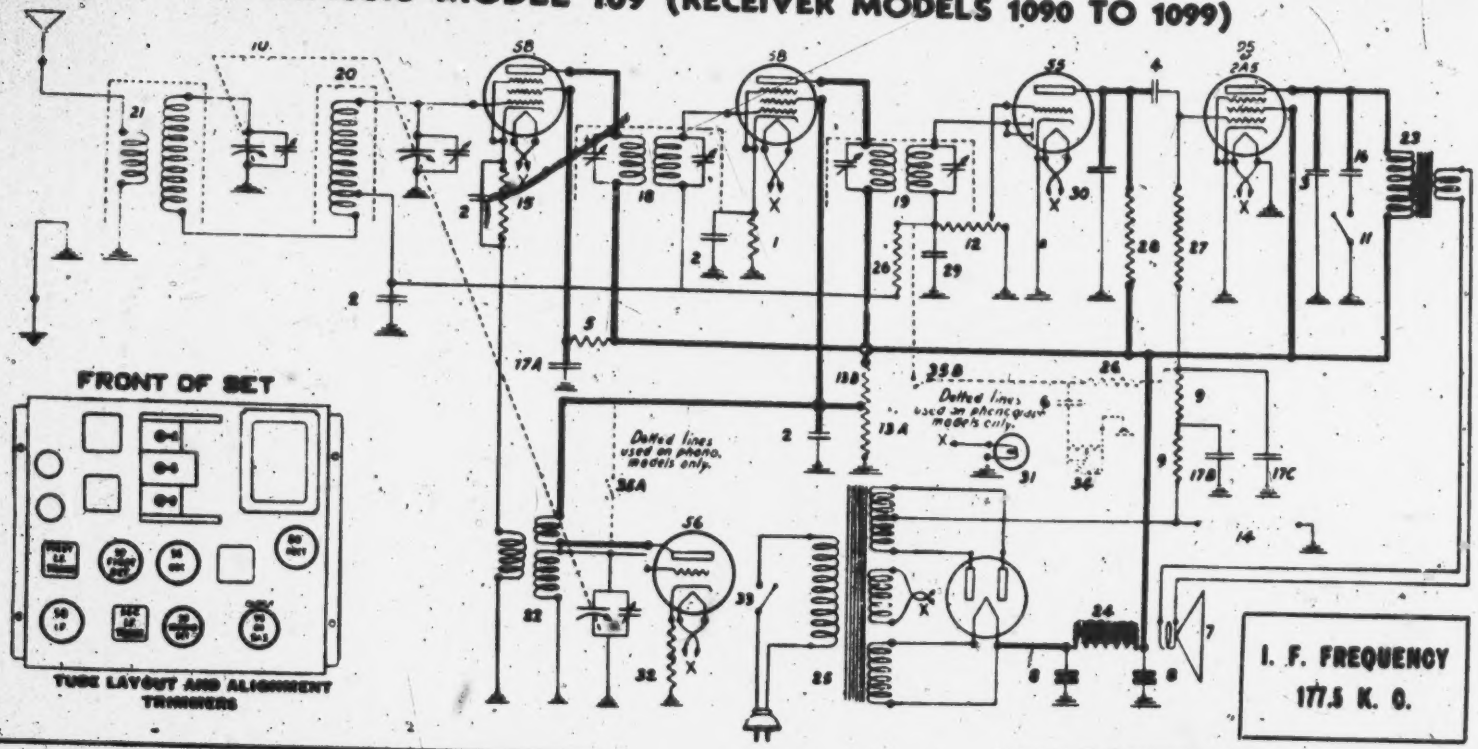
We make no warranty whatsoever in respect to accessories or parts not manufactured by us, as they are usually warranted by their respective manufacturers.

IN WITNESS WHEREOF, this warranty is endorsed by the

Stewart-Warner Corporation, Chicago.

Form 359 Printed in U.S.A.

CHASSIS MODEL 109 (RECEIVER MODELS 1090 TO 1099)



VOLTAGE TABLE

LINE VOLTAGE 115 — VOLUME CONTROL FULL ON

Type of Tube	Tube Circuit	Filament Voltage	Plate Voltage	Screen Grid Voltage	Bias Voltage
56	Osc.	2.40	88		9.6
58	1st Det.	2.40	208	92	5
58	I. F.	2.40	208	92	3.4
55	2nd Det.	2.42	18		
25 or 2A5	Output	2.38	208	208	16.5*
80	Rect.	5.00			

All D. C. voltages measured with respect to ground, using high resistance voltmeter of 1000 ohms per volt. Readings will vary, depending upon voltage range of meter, being higher for higher range instruments. This variation is most marked for second detector plate voltages.

*This reading taken across metal clad bias resistor.

Form 3686—Printed in U. S. A.

109 PARTS LIST

Illus. No.	Part No.	Description	List Price
1	67237	500 ohm [illegible] watt resistor	00.25
2	67294	.1 mfd., 200 volt condenser	.30
3	67290	.01 mfd., 600 volt condenser	.30
4	67299	.02 mfd., 600 volt condenser	.30
5	67936	100,000 ohm, ½ watt resistor	.25
6	81190	.1 mfd., 600 v. round. Phono model only	.35
7	81271	Speaker diaphragm assembly	2.75
8	81247	8 mfd., 165 volt electrolytic round.	1.75
9	81301	150,000 ohm, ½ watt resistor	.25
10	81700	Variable condenser	2.60
11	81721	Tone control switch	.65
12	81722	500,000 ohm, vol. control & S. C. switch	1.25
13	81870	Vol. control & phonograph switch unit	2.10
13A	81724	10,000 ohm, resistor } Wound in	.60
13B		7,500 ohm, resistor } one unit	
14	81725	313 ohm, wire wound resistor	.30
15	81727	1000 ohm, ½ watt resistor	.30
16	81730	.04 mfd., 600 volt condenser with bracket	.35
17A	81786	.5 mfd., 200 volt }	1.30
17B		.25 mfd., 100 volt } in one roll	
17C		.25 mfd., 100 volt }	
18	81787	First I. F. Transformer	2.00
19	81788	Second I. F. Transformer	2.00
20	81764	First detector tuning coil	1.00
21	81768	Antenna coil	1.25
22	81770	Oscillator coil	1.25
23	81774	Output transformer	2.00
24	81779	Speaker field coil	2.00
25	81880	110 volt 60 cy., power transformer	6.25
	81881	220 volt 60 cy., power transformer	6.25
26	81882	400,000 ohm, ½ watt resistor	.30
27	81883	100,000 ohm, ½ watt resistor	.30
28	81810	110,000 ohm 1 watt resistor	.30
29	81811	.00025 mfd., condenser	.30
30	81812	.00031 mfd., condenser	.30
31	81822	2.3 volt pilot light	.25
32	81826	1500 ohm, ½ watt resistor	.25
33	81830	230 volt 60 cy., power transf. (see 81880)	2.75
34, 35	81869	Line Switch. (Separate unit used in phonograph chassis only. Part of volume control on standard chassis)	.40
	81870	Phono chassis type volume control (See 81722)	2.00
36		Phonograph pickup.	
37		Phonograph switch, mounted on back volume control in phonograph models.	

MISCELLANEOUS PARTS NOT SHOWN IN DIAGRAM

67236	Rubber tuning drive bushing	
81839	4-prong socket	
81840	5-prong socket	
81841	6-prong socket	
81842	R. F. coil shield	
81843	Tube shield	
81733	Ground clip	
81838	Tuning dial and gear assembly (see 81879)	
81817	First I. F. coil shield	
81818	Second I. F. coil shield	
81879	Celluloid tuning dial	
38189	Steel washer	
39903	Lock washer	
67711	Rubber washer } Used for rubber	
67712	Rubber bushing } mounting variable condenser.	
67713	Steel bushing	

PLAINTIFFS' EXHIBIT NO. 93, Sheet 30.
(Chassis Model 109 (Receiver Models 1090 to 1099)

728
456
457

PLAINTIFFS' EXHIBIT NO. 93, Sheet 40.

SERVICE DATA FOR MODEL 109 CHASSIS

CIRCUIT DESCRIPTION OF 109 CHASSIS

The Model 109 Stewart-Warner Radio Chassis makes use of a six-tube superheterodyne circuit embodying automatic volume control (A.V.C.) through the action of its type 55 detector tube. An incoming signal is tuned first by a pre-selector circuit to increase selectivity and reduce image frequency interference and then fed into a tuned first detector stage, where it beats with the output of a local oscillator to produce a 177.5 K.C. intermediate frequency signal. This odd frequency is chosen to reduce further any image frequency interference.

The I.F. signal is amplified in an exceptionally high gain stage, and then fed to the diode section of the 55 tube where it is rectified. This rectified signal appears across the 500,000 ohm potentiometer (No. 12 in the diagram) not only at radio frequencies but also as an audio voltage. Any desired portion of this audio voltage is picked up by the sliding arm of the potentiometer and fed to the triode section of the 55 tube, which functions purely as a standard A.F. amplifier. Thus this potentiometer is made to act as the volume control.

The necessary A.V.C. operating potential is developed by virtue of the radio frequency drop across the potentiometer resistance. This potential is smoothed out by an appropriate resistance-capacity filter and applied as a bias to the grids of the first detector and I.F. tubes. Thus as the incoming signal increases or decreases in strength the bias is raised or lowered proportionately and the audio output of the set maintained constant.

Excellent tone quality is realized in this set because of the superior design of the resistance network coupling the triode section of the 55 to the output pentode.

ALIGNING THE 109 CHASSIS

Alignment can be carried out intelligently only if the service man knows the general layout of the set, and how each circuit is affected during the process of alignment. The simplified top view of the chassis appearing on the other side of this sheet gives the layout of the receiver and indicates the names and locations of the various aligning adjustments. The following brief discussion of what actually happens during alignment should be carefully read, using the sketch as a basis before commencing the actual work.

LOCATION AND FUNCTION OF ALIGNING ADJUSTMENTS

The incoming signal is tuned first by the pre-selector "A" stage and then fed into the first detector "B" circuit, where it is tuned again to improve selectivity. These circuits are brought into exact alignment by the two trimmer condensers "A" and "B," pointed out in the attached sketch. The tuned oscillator circuit is so designed that it tunes to a frequency exactly 177.5 K.C. higher than the incoming signal. This circuit is kept in exact step with the other two by means of the oscillator condenser trimmer "O."

The two intermediate frequency (I.F.) transformers are of the tuned input-tuned output type and each winding is tuned by a separate trimmer condenser, making a total of four additional adjustments. The first I.F. transformer is in the steel shield at the right side of the set, while the second I.F. transformer is at the rear of the chassis. The I.F. trimmer adjusting screws can easily be reached through two small holes at the base of each shield, the primary circuit adjustment in each case being at the left and the secondary adjustment at the right.

PRELIMINARY STEPS IN ALIGNING

In aligning the Model 109 it is essential to use a high grade oscillator and sensitive output meter. The I.F. signal fed into the receiver must be very weak or it will cause the A.V.C. circuit to function, making correct alignment impossible. The output meter must be sufficiently sensitive to give a satisfactory reading with this low signal.

Before starting the alignment procedure see that the volume control is full on, and the output meter connected either between the pentode plate and ground through a .25 mfd condenser or across the voice coil, depending upon its sensitivity.

ALIGNING PROCEDURE

With this preliminary discussion clearly in mind, the actual alignment can be started. The following step-by-step routine should be followed for satisfactory results.

1. Set up the oscillator, and tune it to exactly 177.5 K.C. (This frequency can be accurately determined by tuning in a station at either 710 or 1420 K.C. and beating the 4th or 8th harmonic of the oscillator 177.5 K.C. signal against it. To be sure that you have the harmonic of the 177.5 K.C. signal, instead of some other frequency, tune in the other 177.5 harmonics on the broadcast dial. These should come in 177.5 K.C. on either side of the original setting. Do not use the oscillator calibration curve to determine this intermediate frequency.)

2. Connect the oscillator output between the grid cap of first detector tube and chassis.

Adjusting R. F. and Oscillator Circuits

1. Twist the aerial and ground wires of the set together to reduce noise pick-up. Connect the aerial wire to the output of the oscillator and ground both set and oscillator. Adjust the oscillator frequency to 1400 K.C. and carefully tune the receiver to give maximum output. Adjust the oscillator output to produce about one-half full scale deflection of the output meter.

2. Carefully tune the "A" trimmer till the output meter reading reaches a maximum.

Due to the fact that the variable condenser is mounted on rubber cushion supports, pressure of the aligning tool will usually cause it to shift slightly and throw it out of tune. It is therefore necessary to retune the set repeatedly while adjusting any variable condenser trimmer.

3. Retune the set and adjust the "B" trimmer for maximum output.

The third, or "O" trimmer should not be touched unless the set is badly out of calibration at the high frequency end of the dial.

If the set is out of calibration, it can be re-calibrated as follows: Set the tuning dial at the frequency reading of some station between 1200 and 1500 kilocycles only, whose exact frequency is known and which can be picked up without any difficulty. Adjust the oscillator trimmer "O" until this station is brought in with maximum volume. Re-adjust the "A" and "B" trimmers again, since these are always affected by any change in the oscillator tuned circuit.

The receiver should now be perfectly aligned.

REVISIONS

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THIS PRINT SUPERSEDES ANY PRINT DATED PRIOR TO DEC 12 1933

IN-427

PLAINTIFFS' EXHIBIT No. 93, Sheet 41.
(Blueprint I.N. 427)

42 3 GANG VARIABLE CONDENSER

58 56 58 55 PAS 93

1) B-727 100[illegible] 1/2W FIXED RESIS.
2) B-849 150[illegible] 1W FIXED RESIS.
3)
4) 81805 300,000[illegible] 1/2W FIXED RESIS.
5) } 81724 { 10,000[illegible] 2.5W FIXED RESIS.
6) } { 7500[illegible] 1.5W FIXED RESIS.
7) 81722 500,000[illegible] VOLUME CONTROL
8) 81810 110,000[illegible] W. FIXED RESIS.
9) 67938 00,000[illegible] 1W. FIXED RESIS.
10) 81809 150,000[illegible] 1/2W FIXED RESIS.
11) 81738 150,000[illegible] 1/2W. FIXED RESIS.
12) 81381 150,000[illegible] 1/2 W. FIXED RESIS.
13) 81725 3[illegible] W W FIXED RESIS.
14) 67257 50[illegible] 1/2W. FIXED RESIS.

25V LAMP BULB

30) G-67294 .1 MFD. 200V. FIXED COND.
31) G-67294 .1 MFD. 200V. FIXED COND.
32) G-67294 .1 MFD. 200V. FIXED COND.
33) G-67294 .1 MFD. 200V. FIXED COND.
34) G-67299 .02 MFD. 400V. FIXED COND.
35) G-67298 .01 MFD. 600V. FIXED COND.
36) G 81739 .04 MFD. 600V. FIXED COND.
37)
38) G 81756 { .5 MFD. 200V. / 25 MFD. 100V. / 25 MFD. 100V. } ONE CAN.
39)
40) 81347 8 MFD. 450V. ELECTROLYTIC COND.
41) 81347 8 MFD. 450V. ELECTROLYTIC COND.
42) 81700 VARIABLE TUNING COND.
43) 81811 .00026 MFD. FIXED COND.
44) 81812 .00031 MFD. FIXED COND.

80

WHITE GREEN RED YELLOW

ELECTRO DYNAMIC SPEAKER

40) 81768 "A" COIL (PRE SELECTOR)
41) 81764 "B" COIL (1ST DETECTOR)
42) 81770 "O" COIL (OSCILLATOR)
43) 81797 1ST I.F. TRANS. ASSEM.
44) 81788 2ND I.F. TRANS. ASSEM.
45) 81774 OUT PUT TRANS.
46) 81808 POWER TRANS.

47) 81731 TONE CONTROL
48) POWER SUPPLY (SEE BOTH ITEM #7

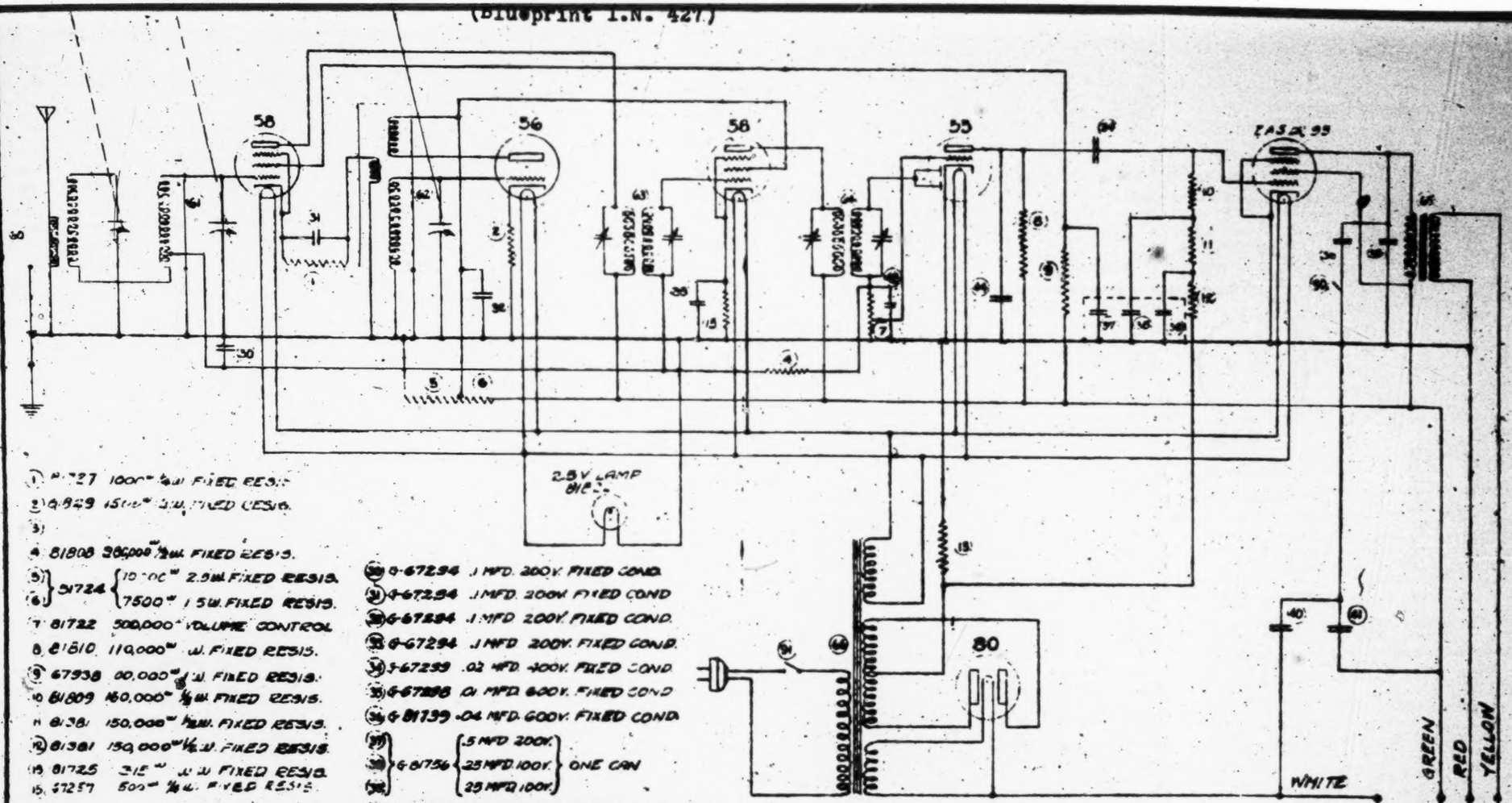
BLK. YEL. GRN. BLK. RED

115 V. 125 V. 230 V. 230 V. 230 V.

PRI. #1 PRI. #2

CAUTION

(Blueprint I.N. 427.)

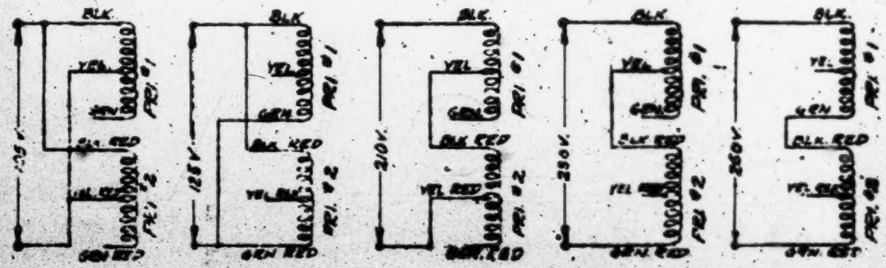


(1) R-727 1000Ω ½W FIXED RESIS.
(2) R-849 15000Ω 1W. FIXED RESIS.
(3)
(4) 81808 30,000Ω ½W. FIXED RESIS.
(5) (6) 51724 { 10,000Ω 2.5W. FIXED RESIS. / 7500Ω 1 5W. FIXED RESIS.
(7) 81722 500,000Ω VOLUME CONTROL
(8) 81810 110,000Ω W. FIXED RESIS.
(9) 67938 80,000Ω ½ W. FIXED RESIS.
(10) 81809 160,000Ω ½ W. FIXED RESIS.
(11) 81381 150,000Ω ½W. FIXED RESIS.
(12) 81381 150,000Ω ½ W. FIXED RESIS.
(13) 81725 .215Ω W. W. FIXED RESIS.
(15) 67257 500Ω ½ W. FIXED RESIS.

(29) G-67294 .1 MFD. 200V. FIXED COND.
(31) G-67294 .1 MFD. 200V. FIXED COND.
(32) G-67294 .1 MFD. 200V. FIXED COND.
(33) G-67294 .1 MFD. 200V. FIXED COND.
(34) G-67239 .02 MFD. 400V. FIXED COND.
(35) G-67298 .01 MFD. 600V. FIXED COND.
(36) G-81739 .04 MFD. 600V. FIXED COND.
(37) (38) (39) G-81756 { .5 MFD 200V. / 25 MFD 100V. / 25 MFD 100V. } ONE CAN
(40) 81347 8 MFD. 450V. ELECTROLYTIC COND.
(41) 81347 8 MFD. 450V. ELECTROLYTIC COND.
(42) 81700 VARIABLE TUNING COND.
(43) 81811 .00025 MFD. FIXED COND.
(44) 81812 .00031 MFD. FIXED COND.

(45) 81768 "A" COIL (PRE-SELECTOR)
(46) 81764 "B" COIL (1st DETECTOR)
(47) 81770 "C" COIL (OSCILLATOR)
(48) 81757 1st I.F. TRANS. ASSEM.
(49) 81758 2nd I.F. TRANS. ASSEM.
(50) 81774 OUT PUT TRANS.
(51) 81809 POWER TRANS.

(52) 81724 TONE CONTROL
(53) POWER SUPPLY UNIT WITH ITEM "7"



POWER TRANS. PRIMARY CONNECTIONS FOR R-109-E MODELS

CIRCUIT DIAGRAM R-103A-E

JAN. - 1933

IN-427

PLAINTIFFS' EXHIBIT NO. 93, Sheet 42 462- 463

STEWART-WARNER
CHASSIS MODEL 109
INSTRUCTIONS

ANTENNA SYSTEM

Satisfactory radio reception is more dependent upon a proper antenna-ground installation than upon any other factor outside of the set itself. It is the function of the antenna system to collect the minute energy radiated by the broadcast station and carry it to the set. Therefore if you wish to insure yourself consistent and enjoyable reception it is quite important to install a suitable antenna system to pick up and carry the radio signal to your set.

The most satisfactory aerial for any particular location will vary widely depending upon local structural details and sources of interference. As a general rule, a good outside aerial f m fifty to seventy-five feet long including lead-in will give best results.

The aerial proper should consist of a length of copper wire insulated at each end with a glazed porcelain or glass insulator. It should be erected as far as possible from buildings, trees, and other obstructions. Do not run it alongside of electric wires, a tin roof, or any metallic structure. Avoid placing the aerial above or below exposed wires installed by the electric light or telephone company.

Where it is not possible to erect an outside aerial, an inside one consisting of sixty feet of insulated wire led around the picture molding of the room makes a fair substitute.

LEAD-IN

The lead-in from the outside aerial should consist of a heavily insulated copper wire. In certain locations where noisy reception is experienced due to interference from electrical machinery in the vicinity of the set, shielded lead-in wire may prove helpful in reducing interference. In extreme cases, special types of aerials and lead-ins designed to balance out interference may be erected. See your local dealer for further information on this point.

INSTALLATION OF GROUND

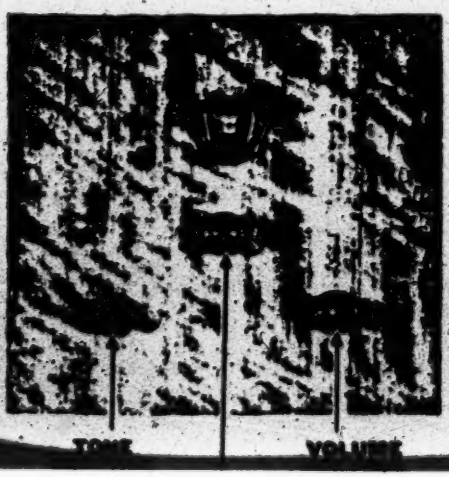
The ground connection is just as important as the aerial.

In a great number of installations a satisfactory ground can be made by connecting to a cold water pipe. This connection should be made by soldering the wire directly to the pipe or by some approved form of ground clamp. The pipe should be thoroughly cleaned and all paint and corrosion removed at the point at which the connection is made. Radiators may also be used for grounds, but do not always give good results.

Very frequently, when the wiring of a home conforms to underwriters' specifications so that all conduit piping is grounded a wire fastened to the metal plate of a base-board outlet makes a satisfactory ground.

HOW TO CONNECT THE SET

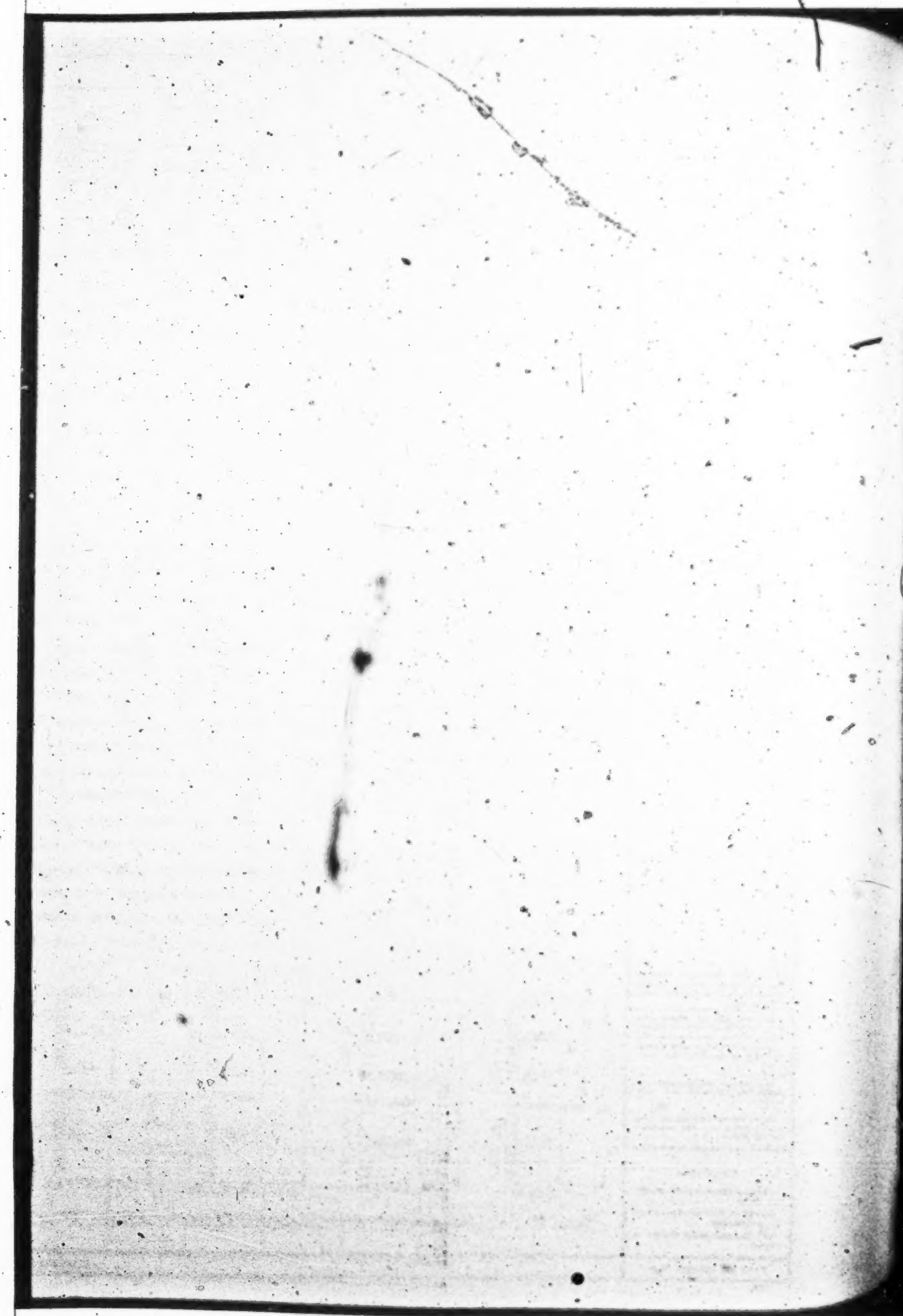
Before connecting up the set, be sure that your home is wired for the voltage and current for which the set is designed as indicated on the name plate on the rear of the chassis. If you are in doubt, call up your local power company for the necessary information. Connecting the set to a supply outlet furnishing the wrong type of current will result in improper operation or damage.



Your radio receiver is designed to operate at 115 volts. If the voltage in your home rises above 120 volts, you should purchase a suitable voltage regulator to reduce the line voltage to the proper value so that your radio tubes will give you satisfactory service.

Installation of the set can best be accomplished in the following manner:

1. Remove the packing material holding the tubes in position. Note that some of the tubes have metal caps over which are fitted small clips. Be sure the metal clips are fitted over the caps



STEWART-WARNER
CHASSIS MODEL 109
INSTRUCTIONS

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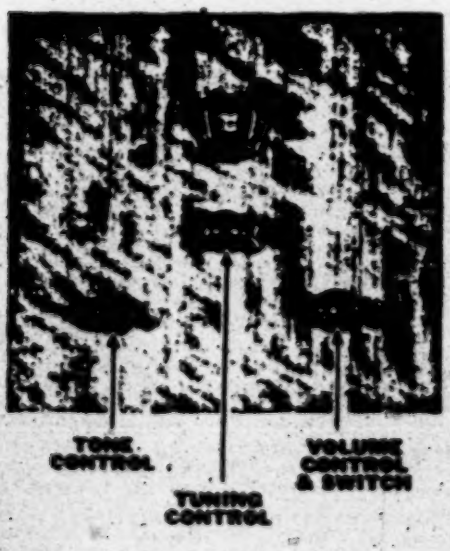

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Installation of the set can best be accomplished in the following manner:

1. Remove the packing material holding the tubes in position. Note that some of the tubes have metal caps over which are fitted small clips. Be sure the metal clips are fitted over the caps, and do not touch the tube shields.

2. Connect the aerial to the blue wire extending from the back of the chassis. The ground should be connected to the clip on the back of the chassis.

3. Plug the extension cord of the set into the most convenient socket.

PLAINTIFFS' EXHIBIT NO. 93, Sheet 43 464 - 465

TUNING INSTRUCTIONS

—Refer to the illustration before attempting to tune the set for the first time.

1. Turn on the set by turning the right hand, or volume control knob all the way to the right (clockwise).

2. Wait a few seconds for the tubes to warm up. There should be a slight rushing or crackling sound coming from the speaker to indicate the set is ready to be operated.

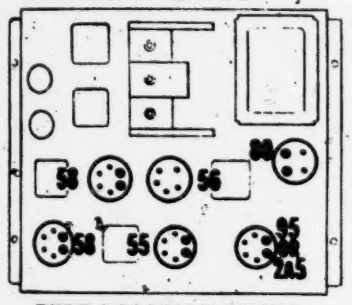
3. Now turn the center tuning control slowly to bring in stations. You will notice that as you tune either into or out of a station the program will be accompanied by a certain amount of hissing and distortion. It is very important that you tune carefully to the exact center of the dial space covered by the station to obtain fullest and deepest tone.

4. After the desired station is tuned in correctly, the tone control may be adjusted to suit the individual requirements of the listener.

In addition to regulating tone, the tone control has a very important function in reducing static and those interference noises created by the operation of electrical machinery. As it happens, these crackling and frying noises are very largely composed of the higher tones, so that turning the tone control to the right minimizes this interference to a very great extent.

5. The number system on the dial of your radio receiver is conveniently calibrated to indicate broadcasting station frequencies in kilocycles. However, the final zero has been omitted from the dial numbers, so that dial number 110 corresponds to 1100 kilocycles, dial position 55 to 550 kilocycles, and so on.

FRONT OF SET



TUBE LOCATION CHART

6. It may be noticed occasionally when listening to distant stations that the background noise increases and decreases in a regular fashion, although the program itself does not fluctuate in volume. This is due entirely to fading of the incoming wave. The automatic volume control prevents any change in volume, but as the signal tends to fade out, the sensitivity of the set automatically increases, and the static that is always present becomes greater in proportion to this weaker signal so that it is heard more loudly.

TUBES USED

Six tubes are used. Their type numbers and positions in the set are shown in the tube location diagram.

IMPORTANT!

Your Stewart-Warner Radio Receiver is not guaranteed unless you have filled in and mailed the guarantee registration card accompanying each set within ten days after the purchase of the set. Be sure and ask your dealer for this card if it does not accompany the receiver.

WARRANTY

This is to certify that we, the STEWART-WARNER CORPORATION, Chicago, Illinois, warrant the Stewart-Warner Model R-109 Radio Receiver manufactured by us, to be free from defects in material and workmanship under normal use and service, our obligation under this warranty being limited to repairing or replacing, through an accredited Stewart-Warner distributor, any part or parts of said product that in our judgment show evidence of such defect provided that said product shall have been registered with us at the time of purchase; and provided further, that said product shall be returned to the distributor, transportation prepaid, within 90 days from the date of delivery thereof by the dealer to the purchaser.

This warranty is expressly in lieu of all other warranties, expressed or implied, and of all other obligations on our part, and no representative or other person is authorized or permitted to make any warranty or assume for this corporation any liability not strictly in accordance with the foregoing.

This warranty shall not apply to any product which has been tampered with or altered in any way, or which has been subjected to misuse, negligence or accident, or which has the serial number altered, effaced or removed.

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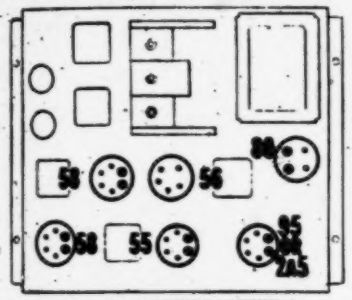

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This warranty is expressly in lieu of all other warranties, expressed or implied, and of all other obligations on our part, and no representative or other person is authorized or permitted to make any warranty or assume for this corporation any liability not strictly in accordance with the foregoing.

This warranty shall not apply to any product which has been tampered with or altered in any way, or which has been subjected to misuse, negligence or accident, or which has the serial number altered, effaced or removed.

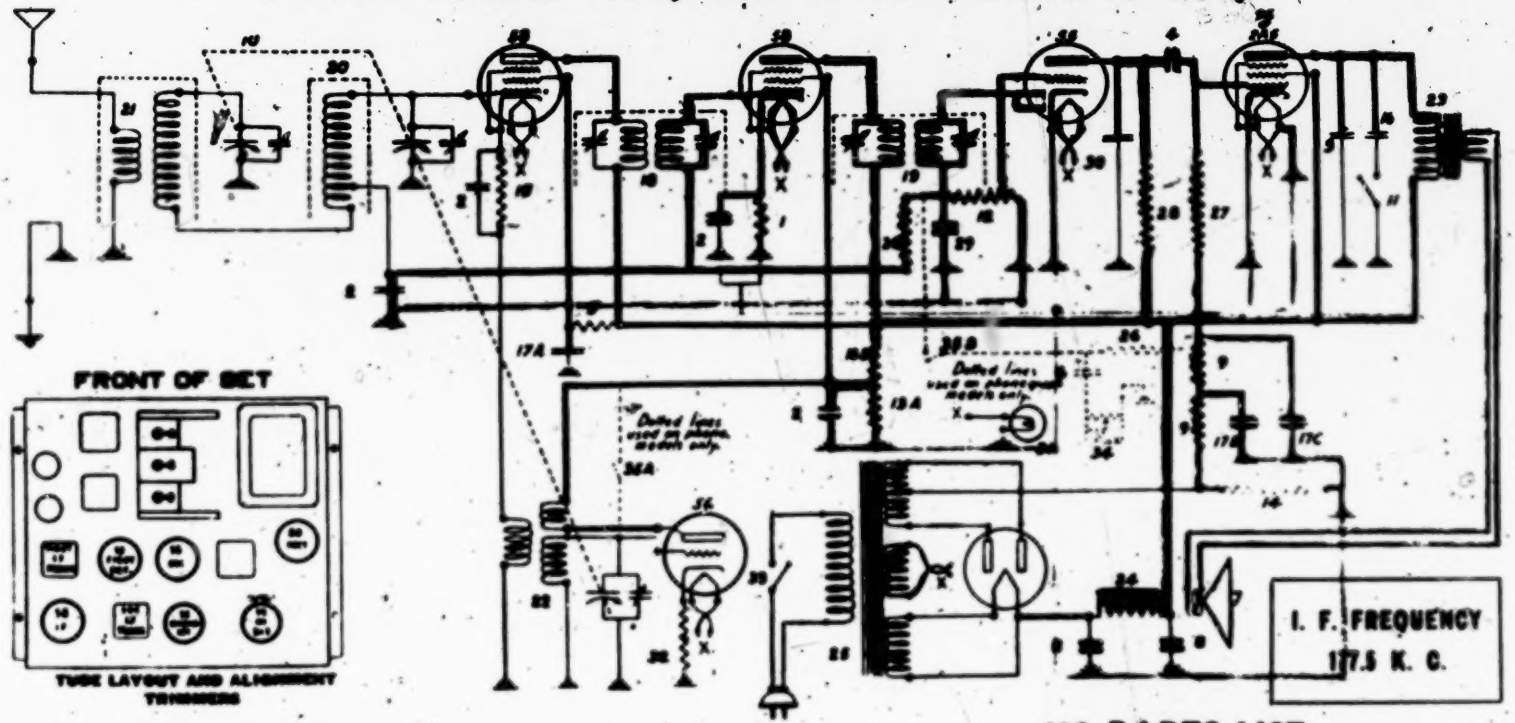
We make no warranty whatsoever in respect to accessories or parts not manufactured by us, as they are usually warranted by their respective manufacturers.

IN WITNESS WHEREOF, this warranty is endorsed by the

Stewart-Warner Corporation, Chicago

Form 3667. Printed in U.S.A.

CHASSIS MODEL 109 (RECEIVER MODELS 1090 TO 1099)



VOLTAGE TABLE

LINE VOLTAGE 115 — VOLUME CONTROL FULL ON

Type of Tube	Tube Circuit	Filament Voltage	Plate Voltage	Screen Grid Voltage	Bias Voltage
56	Osc.	2.40	88		9.6
58	1st Det.	2.40	208	92	5
58	I. F.	2.40	208	92	3.4
55	2nd Det.	2.42	18		
95 or 2A5	Output	2.38	200	208	16.5*
80	Rect.	5.00			

All D. C. voltages measured with respect to ground, using high resistance voltmeter of 1000 ohms per volt. Readings will vary, depending upon voltage range of meter, being higher for higher range instruments. This variation is most marked for screened detector plate voltage.

*This reading taken across metal clad ballast resistor.

Form 5609—Printed in U. S. A.

109 PARTS LIST

Diag. No.	Part No.	Description	List Price
1	67287	200 ohm, ½ watt resistor	$0.25
2	67296	.1 mfd., 200 volt condenser	.30
3	67292	.001 mfd., 600 volt condenser	.30
4	67299	.02 mfd., 600 volt condenser	.30
5	67282	100,000 ohm, ½ watt resistor	.25
6	81300	.1 mfd., 200 v. cond. Phono model only	.35
7	81276	Speaker diaphragm assembly	2.75
8	81347	8 mfd., 450 volt electrolytic cond.	1.75
9	81301	150,000 ohm, ½ watt resistor	.25
10	81700	Variable condenser	5.00
11	81721	Tone control switch	.65
12	81722	500,000 ohm, pot. control & A. C. switch	1.25
	81870	Vol. control & phonograph switch unit	2.10
13A	81724	1,000,000 ohm, resistor (Used in	.60
13B		1,500 ohm, resistor one unit)	
14	81725	315 ohm, wire wound resistor	.70
15	81727	1000 ohm, ½ watt resistor	.25
16	81730	.04+.04 .600 volt condenser with bracket	.55
17A	81726	.1 mfd., 200 volt	1.50
17B		.05 mfd., 400 volt in one roll	
17C		.05 mfd., 400 volt	
18	81727	First I. F. Transformer	2.00
19	81728	Second I. F. Transformer	2.00
20	81764	Plate detector tuning coil	1.00
21	81765	Antenna coil	1.25
22	81770	Oscillator coil	1.25
23	81771	Output transformer	3.00
24	81772	Speaker field coil	4.00
25	81800	110 volt 60 cy., power transformer	6.00
	81801	220 volt 60 cy., power transformer	6.25
26	81802	350,000 ohm, ½ watt resistor	.25
27	81804	150,000 ohm, ½ watt resistor	.25

Diag. No.	Part No.	Description	List Price
28	81810	110,000 ohm 1 watt resistor	$0.25
29	81811	.0002 mfd., condenser	.30
30	81812	.00031 mfd., condenser	.30
31	81822	2.5 volt pilot light	.25
32	81870	1500 ohm, watt resistor	.25
33	81864	250 volt 60 cy., powertransf. (see 81800)	6.00
		Line Switch. (Separate unit used in phonograph chassis only. Part of volume control on standard chassis)	.35
	81870	Phono-Radio type volume control (See 81722)	2.10
34		Phonograph pickup.	
35		Phonograph switch, mounted on back volume control in phonograph models.	

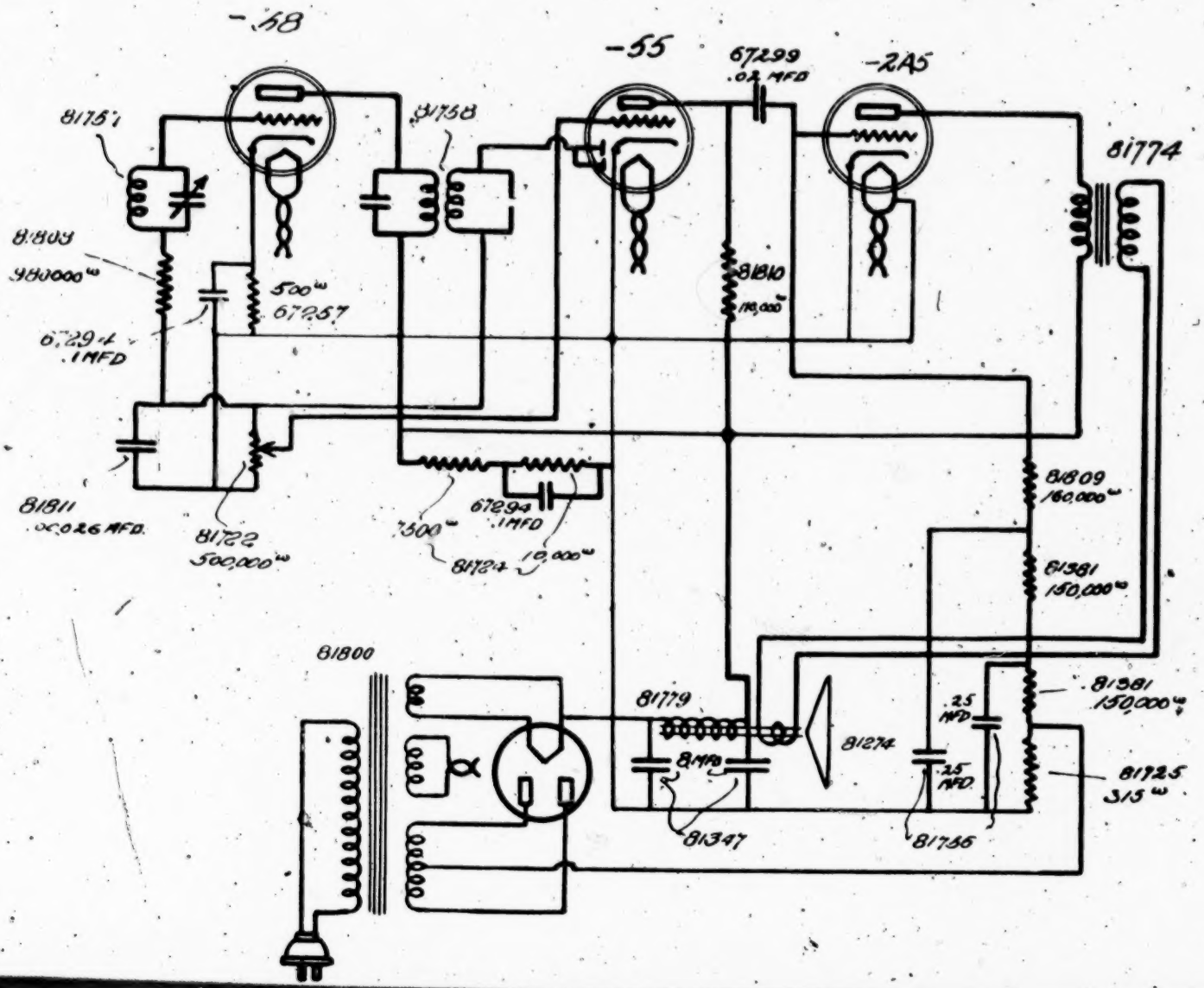
MISCELLANEOUS PARTS NOT SHOWN IN DIAGRAM

67236	Rubber tuning drive bushing	.05
81699	4-prong socket	.05
81810	5-prong socket	.05
81811	6-prong socket	.05
81808	R. F. coil shield	.25
81823	Tube shield	.05
81733	Ground clip	.05
81808	Tuning dial and gear assembly (see 81879)	.75
81817	First I. F. coil shield	.25
81819	Second I. F. coil shield	.25
81879	Celluloid tuning dial	.75
36489	Steel washer	.05
39983	Lock washer (Used for rubber mounting variable condenser.)	.10 doz.
67711	Rubber washer	.05
67712	Rubber bushing	.05
67713	Steel bushing	.05

PLAINTIFFS' EXHIBIT NO. 94,
(Colored photostat of set SW 109)

-466-
467

~ Stewart-Warner Model 109 ~



PLAINTIFFS' EXHIBIT NO. 95.
(Simplified diagram of set SW 109)

PLAINTIFFS' EXHIBIT No. 96.
(Copy of speaker circuit wiring diagram made on blackboard by Witness, Dr. Lee.)

470-
471

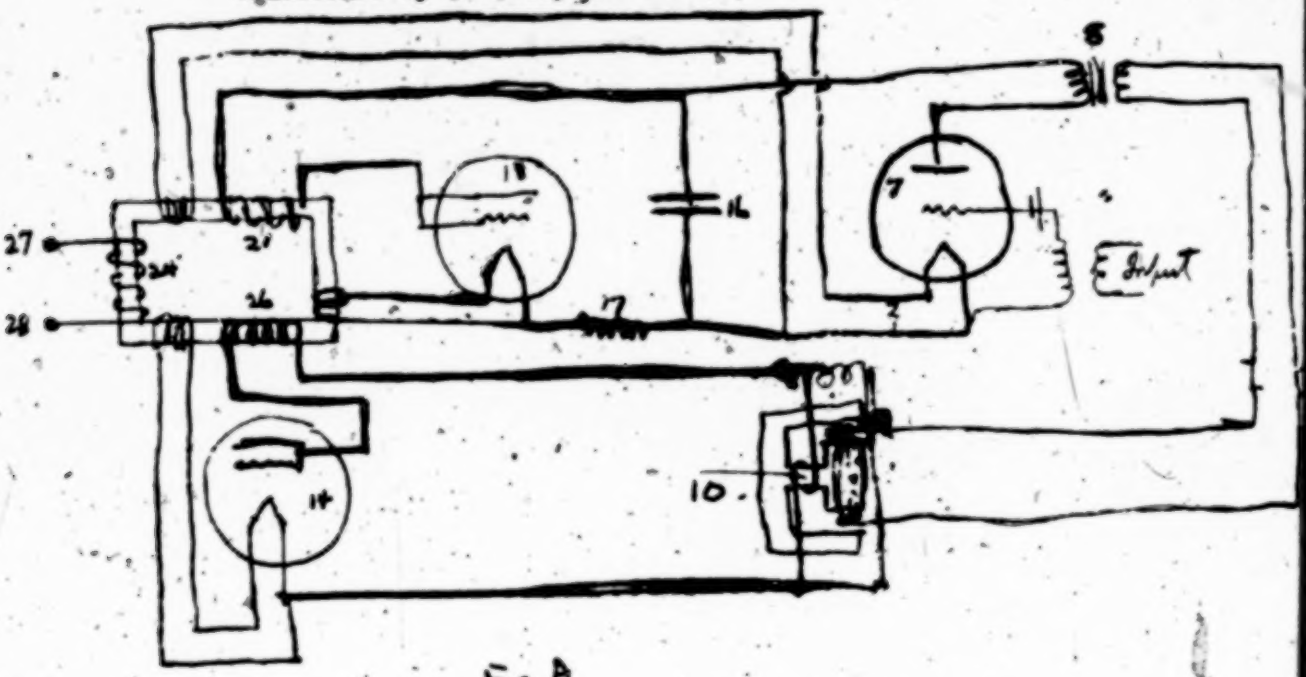
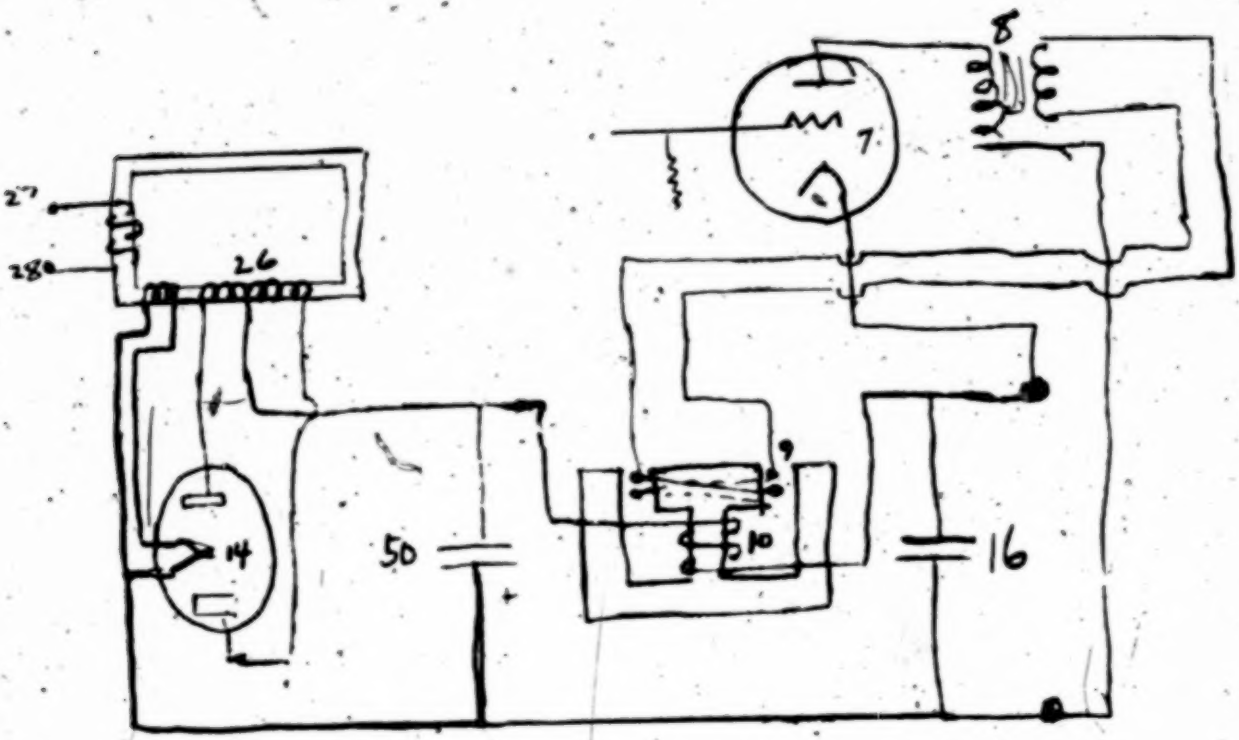


Fig A

Plfs X96



PLAINTIFFS' EXHIBIT No.97,
(Christian Science Herald, Jan.10.1928, Page 10)

736
472-473

RADIO

Electro-Dynamic Speaker Is Remarkable Development

Cone Fastened to Coil of Wire Instead of Driving Pin Excels on Low Notes

Many loudspeakers have been featured during the last few years, the majority being cones working on the electro-magnetic idea, carried to a very high point of development in the W. E. cone. This year has seen the introduction of a type of speaker for popular use which considerably exceeds the W. E. cone on the lower registers, and that is the electro-dynamic cone. We have never heard any reproduction of low tones that compare with our trials on these units. The following discussion by one of the Magnavox engineers is interesting, primarily because this company has specialized in electrodynamic speaker design for many years. His basic idea, combined with a cone air actuating device, is now a leading factor in set design which incorporates higher-priced apparatus.

By AUSTIN ARMER

Loudspeaker development for use with radio receiving sets, and more recently in connection with electric phonographs, has been of interest because few striking novelties in design have presented themselves. The horn type of speaker was standard construction a few years ago, until it gave way to the cone-speaker, which promised to displace the horn entirely. But before any such displacement took place, the horn type speaker took on a new lease of life by virtue of the use of a long air column of proper design. Thus at present the two types are equally important, and it therefore appears that perfection is to be realized only by the refinement of the driving unit, whether the actual sound source be a cone or an air column.

It was this realization that prompted the engineers of the Magnavox Company, at Oakland, Calif., to develop a driving unit of unique design, and of a type that would be free from two of the greatest evils of existing types, namely, the stiffness of the vibrating element, and the small distance through which this element was permitted to move.

Stiffness, especially in a cone speaker, causes distortion in two ways. First, it tends to give the speaker a natural period or resonance, which has the effect of causing certain notes in musical reproduction to be over-accentuated. Second, it prevents the reproduction of extremely low tones, because the energy of these low tones is not as great as some of the higher frequencies, and any resistance to the motion of the vibrating element tends to suppress the low tones more than the high.

Limiting the distance through which the vibrating element can move means limiting the sound energy available from the speaker, and this limitation is most noticeable in the low frequencies, since the cone or diaphragm must move through a greater distance when reproducing low frequencies than when reproducing high frequencies of the same energy.

The Magnavox Dynamic Speaker uses as a sound emitter a small paper cone, seven inches in diameter, and this cone is caused to vibrate to and fro, not by the magnetic attraction of an iron armature, but by the force exerted on a powerful magnetic field by the current in a small coil, which is mounted directly upon the cone. The construction of the unit is

The problem of exciting the powerful field magnet seems, when first considered, a serious obstacle, in view of the fact that about four watts of direct current power are required for this purpose. As a matter of fact, however, this problem has been solved by offering to the user of the speaker a choice of field coil windings. There are two standard windings available, one for use with battery-operated sets, and consuming six-tenths of an ampere at six volts, and another designed for operation at 100 volts, and consuming only 40 milliamperes. The six-volt type is designated as the R-4 unit, and the 100 volt as the R-5 unit.

The application of the R-5 unit to A. C. operated receiving sets demonstrates its flexibility of adaptation. Since the inductance is very high (from 20 to 30 henrys) it makes an excellent choke-coil in the filter system of a power pack. In case it becomes desirable to use the R-5 unit with a power pack already equipped with choke-coils, the field winding can be substituted for a portion of the resistance in the voltage divided circuit. For the information of those desiring to make this application, the resistance of the field winding is 2500 ohms.

Still another means of exciting the R-5 field coil is to connect it directly to a 110-volt, direct-current power source, in case the user is in a metropolitan district where the power service is direct current. Although a slight ripple, as from the direct current supply, or the residual ripple in a filter choke is not at all objectionable, the R-5 unit cannot be excited by alternating current.

So far nothing has been mentioned concerning the installation of the speaker unit. If the speaker is purchased in a cabinet as furnished by the Magnavox Company (either the Beverly, Aristocrat, or Lobby model), the unit is provided with proper baffle and its mounting need be given no further consideration. But if it is desired to purchase either the R-4 or R-5 unit as such, and mount it in a console or other cabinet which may be at hand, certain precautions must be taken if the best performance is to be realized.

Because the Magnavox Dynamic Speaker uses for a sound-emitter a small cone acting as a plunger or piston, the back of the cone radiates sound waves just as the front does, but out of phase with the waves emitted by the front surface. If the speaker unit is permitted to operate in the open, the waves issuing from the front of the cone will almost completely interfere with those issuing from the back, and the result will be very low volume and complete absence of any low tones.

Now if the speaker be placed in a baffle in such a manner that the air cannot circulate from the front to the back of the cone, the destructive interference previously encountered disappears, and the true quality of the speaker is realized. The size of the baffle is not critical, but the greater its area, the greater will be the response to the very low frequencies. A minimum width of 20 inches should be observed in designing a baffle, but this restriction does not mean that the cabinet containing the speaker be not less than 20 inches wide. This is because the sides of the cabinet as well as the front have a certain baffling effect.

The material of the baffle is not critical, but should not be too thin. Wood is the most readily used material, and is thoroughly satisfactory as long as it is over ¾ of an inch thick. If the baffle is too thin, it will introduce an unnatural drummy quality of reproduction.

In conclusion, let it be stated that the Dynamic Speaker will undoubtedly be the favorite of manufacturers of high-class receiving sets during 1928, and some of the leading manufacturers of quality sets are already using it as standard equipment. Consequently, anyone desiring the utmost in quality reproduction from an existing set should investigate the Dynamic Speaker.

IN THE SH

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In addition to these ships operating in the southern Florida and Cuban route, the Clyde Line maintains ships between New York, Charleston and Jacksonville, all of the vessels of the fleet having been built within the past two years in connection with the comprehensive replacement program in which the company engaged.

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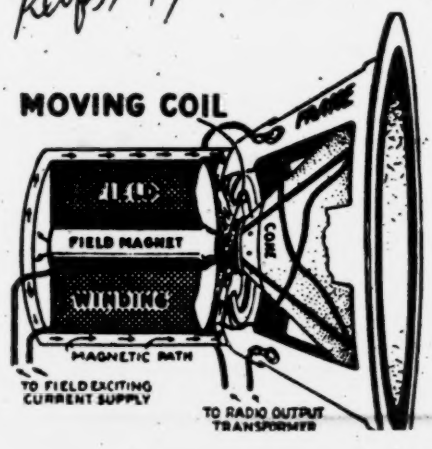
Details of Magnavox Cone



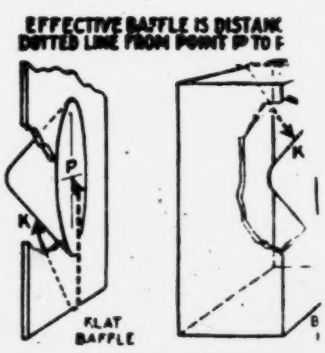


Figure 2

Electro-Dynamic Speaker Is Remarkable Development

Cone Fastened to Coil of Wire Instead of Driving Pin Excels on Low Notes

Many loudspeakers have been featured during the last few years, the majority being cones working on the electro-magnetic idea, carried to a very high point of development in the W. E. unit. This year has seen the introduction of a type of speaker for popular use which considerably exceeds the W. E. cone on the lower registers, and that is the electro-dynamic cone. We have never heard any reproduction of low tones that compare with our trials on these units. The following discussion by one of the Magnavox engineers is interesting, primarily because this company has specialized in electrodynamic speaker design for many years. His basic idea, combined with a cone air actuating device, is now a leading factor in set design which incorporates higher-priced apparatus.

By AUSTIN ARMER

Loudspeaker development for use with radio receiving sets, and more recently in connection with electric phonographs, has been of interest because few striking novelties in design have presented themselves. The horn type of speaker was standard construction a few years ago, until it gave way to the cone-speaker, which promised to displace the horn entirely. But before any such displacement took place, the horn type speaker took on a new lease of life by virtue of the use of a long air column of proper design. Thus at present the two types are equally important, and it therefore appears that perfection is to be realized only by the refinement of the driving unit, whether the actual sound source be a cone or an air column.

It was this realization that prompted the engineers of the Magnavox Company, at Oakland, Calif., to develop a driving unit of unique design, and of a type that would be free from two of the greatest evils of existing types, namely, the stiffness of the vibrating element, and the small distance through which this element was permitted to move.

Stiffness, especially in a cone speaker, causes distortion in two ways. First, it tends to give the speaker a natural period or resonance, which has the effect of causing certain notes in musical reproduction to be over-accentuated. Second, it prevents the reproduction of extremely low tones, because the energy of these low tones is not as great as some of the higher frequencies, and any resistance to the motion of the vibrating element tends to suppress the low tones more than the high.

Limiting the distance through which the vibrating element can move means limiting the sound energy available from the speaker, and this limitation is most noticeable in the low frequencies, since the cone or diaphragm must move through a greater distance when reproducing low frequencies than when reproducing high frequencies of the same energy.

The Magnavox Dynamic Speaker uses as a sound emitter a small paper cone, seven inches in diameter, and this cone is caused to vibrate to and fro, not by the magnetic attraction of an iron armature, but by the force exerted on a powerful magnetic field by the current in a small coil, which is mounted directly upon the cone. The construction of the unit is such that this coil and the attached cone can move about a quarter of an inch without meeting any more resistance than that of the cone suspension. So lightly suspended is this cone, that one can deflect it by merely blowing on it.

The problem of exciting the powerful field magnet seems, when first considered, a serious obstacle, in view of the fact that about four watts of direct current power are required for this purpose. As a matter of fact, however, this problem has been solved by offering to the user of the speaker a choice of field coil windings. There are two standard windings available, one for use with battery-operated sets, and consuming six-tenths of an ampere at six volts, and another designed for operation at 100 volts, and consuming only 40 milliamperes. The six-volt type is designated as the R-4 unit, and the 100 volt as the R-5 unit.

The application of the R-5 unit to A. C. operated receiving sets demonstrates its flexibility of adaptation. Since the inductance is very high (from 20 to 30 henrys) it makes an excellent choke-coil in the filter system of a power pack. In case it becomes desirable to use the R-5 unit with a power pack already equipped with choke-coils, the field winding can be substituted for a portion of the resistance in the voltage divided circuit. For the information of those desiring to make this application, the resistance of the field winding is 2500 ohms.

Still another means of exciting the R-5 field coil is to connect it directly to a 110-volt, direct current power source, in case the user is in a metropolitan district where the power service is direct current. Although a slight ripple, as from the direct current supply, or the residual ripple in a filter choke is not at all objectionable, the R-5 unit cannot be excited by alternating current.

So far nothing has been mentioned concerning the installation of the speaker unit. If the speaker is purchased in a cabinet as furnished by the Magnavox Company (either the Beverly, Aristocrat, or Lobby models), the unit is provided with proper baffle and its mounting need be given no further consideration. But if it is desired to purchase either the R-4 or R-5 unit as such, and mount it in a console or other cabinet which may be at hand, certain precautions must be taken if the best performance is to be realized.

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Details of Magnavox Cone

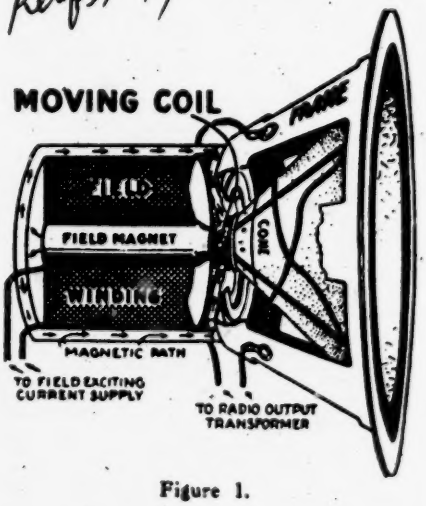

Figure 1.

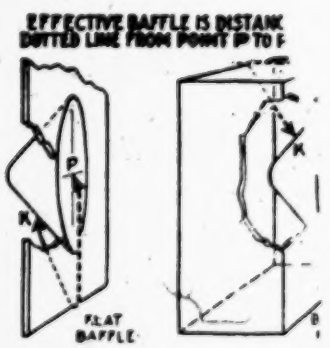

Figure 2

474 — 475

PLAINTIFFS' EXHIBIT NO. 98, Sheet 1
(Letter to Magnavox from Dunmore dated June 10,1922.

2371 Champlain St. N.W.,
Washington, D.C.,
June 10, 1922.

The Magnavox Company,
Oakland, Calif.

Dear Sirs Attention: The General Manager

Mr. T.D. Lovell and I have on filed in the United States Patent Office an application for letters patent on an audio Power Amplifier, which is operated entirely from the 110 volt A.C. house lighting circuit including the D.C. field coil of the magnavox.

You have undoubtedly seen press notices of the complete radio-audio amplifier which we have developed (See lower right hand colum, page 27 June issue of Radio) and which also operates entirely from the 110 volt A.C. line, no A or B batteries being required. It is expected that this device will soon be on the market and it appears to us that the combination of it with your power amplifier and magnavox worked on the principles of our application would make an admirable combination.

As the elimination of batteries is bound to come, or rather has come, we think it will be worth your while to keep up to date and suggest that you arrange to have a representative interview us.

Yours truly,

476-477

PLAINTIFFS' EXHIBIT No. 98,
Sheet 2.
(Reply of Magnavox to letter of Dunmore of June 10, 1922).

THE MAGNAVOX COMPANY

[redacted]

GENERAL OFFICE AND FACTORY
2701-2708 EAST 16TH STREET
OAKLAND, CALIFORNIA

June 19, 1922

Mr. F. M. Dunmore,
2371 Champlain St. N. W.,
Washington, D. C.

Dear Sir:

We are very much interested in your letter of June 10th, although it is only one of several which have recently come to us regarding the use of AC on power amplifier.

It is manifestly impossible for us to judge the merits of such an apparatus without an extensive test and we would be pleased to have you submit one sample to our engineers for test in order that we may determine its value to us.

Yours very truly,

THE MAGNAVOX COMPANY

By H Metcalf

H. E. Metcalf
Sales Dept.

HEM:DES

478-479

PLAINTIFFS' EXHIBIT No. 98, Sheet 3.
(Reply of Dunmore to letter of Magnavox of June 19, 1922)

4371 Champlain Av. N.W.,
Washington, D.C.,
June 28, 1922.

Mr. H. W. Metcalf,
The Magnavox Co.,
Oakland, Calif.

Dear Sir:

Subject: Power Amplifier Using C Supply for Plate and Filament.

I have received your letter of June 19, 1922. I regret to state that I am not in a position financially to furnish you with a complete AC Power Amplifier. In the radio laboratory where Mr. Lowell and I are working, we were able to obtain the necessary equipment which we connected up and, after considerable experimentation, we obtained a workable device which we are covering with a patent application.

We should be glad to duplicate the circuit arrangement and make tests should it be possible for one of your representative engineers to be here to witness the tests.

If you will refer to the forth coming July issue of the Journal of the American Institute of Engineers, you will find an article by Mr. Lowell on a Radio-audio Amplifier using AC Power to Supply Plate Voltage and Filament Current. The audio circuit of this amplifier will show to some extent, the method we are using but the paper does not go into details.

It would be appreciated if you will bring this letter to the attention of your engineers, as we are sure that he will find, by reference to the above mentioned article, that we have something that will at least warrant an investigation.

Yours truly,

PLAINTIFFS' EXHIBIT No. 99, Sheet).
(Letter to General Electric Co., July 28, 1923)

July 28, 1923.

National Lamp Works,
General Electric Co.,
Schenectady, N.Y.

Gentlemen:

Will you please quote me prices in dozen lots for tubes containing just a filament and a plate electrode on the order of the old Fleming valve. I am desirous of using a number of these old type of tubes and would like to know at what rate you could supply me.

Yours very truly,

JBB:LM

GENERAL ELECTRIC COMPANY
GENERAL OFFICE
SCHENECTADY, N. Y.

In Reply Refer to

PLAINTIFFS' EXHIBIT NO. 99, Sheet 2.
(Reply of General Electric Co. dated August 3, 1933 to letter of July 28, 1933).

August 3, 1923.

Mr. John B. Brady,
Ouray Building,
Washington, D.C.

Dear Sir:-

This is in reply to your recent letter requesting prices on two element tubes of the Fleming Valve Type. We already manufacture two element tubes known as Kenotrons and it may that either our UV-216 which is a 20 watt tube or our UV-217 which is a 100 watt tube might answer your purpose. These tubes are on sale at most Radio Supply Houses, and we therefore, would suggest that you try either one of these tubes to see whether or not they would not meet your requirements.

Very truly yours,

SUPPLY DEPARTMENT

JHC:ELM

PLAINTIFFS' EXHIBIT NO. 100, Sheet 1,
(Letter to Westinghouse Elec. & Mfg. Co. dated July 28, 1923).

July 28, 1923.

estinghouse Lamp Works.
165 Broadway,
New York City.

Gentlemen:

will you please quote me prices in dozen lots for tubes containing just a filament and a plate electrode on the order of the old Fleming valve. I am desirous of using number of these old type of tubes and would like to know at what price you could supply me.

Yours very truly,

JBB:

PLAINTIFFS' EXHIBIT NO. 100, Sheet 2.

Reply of

Westinghouse Electric & Manufacturing Company

165 Broadway, New York

August 3, 1923

John B. Brady
Ouray Bldg.
Washington, D. C.

Dear Sir:

We have your letter of July 28 addressed to the Westinghouse Lamp Co. and note that you require a tube containing just a filament and plate electrode. You will please note that an order to build such a tube will seriously interfere with our present production as the tube would have to be built in our Laboratory and Research Department and the cost would therefore be exceedingly excessive, aside from the fact that delivery would be considerably delayed.

If you cannot secure these tubes through other sources and are still interested regardless of cost, we will be very glad to take the matter up with our Research Department and determine if we could furnish such a tube and at what price.

PD has not seen this

Very truly yours,

T. L. SCHWARTZ

TLS/AT

ASST. MGR. RADIO DIVISION

PLAINTIFFS' EXHIBIT NO. 101, SHEET 1, (License to Brandes Products Corporation, dated Oct. 1, 1927)

LICENSE TO BRANDES PRODUCTS CORPORATION

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THIS AGREEMENT made this 1st day of October, 1927, by and between FRANCIS W. DUNMORE, of Washington, District of Columbia, PERCIVAL D. LOWELL, of Richmond Hill, New York, and JUBILIER CONDENSER CORPORATION, a Delaware corporation, having a place of business at 4377 Bronx Boulevard, New York City, (hereinafter called the Licensors), and BRANDES PRODUCTS CORPORATION, a corporation existing under the laws of the State of New Jersey, and having its principal office and place of business at 200 Mt. Pleasant Avenue, Newark, New Jersey, Licensee:

WITNESSETH:

WHEREAS, Lowell and Dunmore are the inventors of certain new and useful improvements in radio receiving apparatus wherein the circuits of electron tubes used in radio reception are supplied from the ordinary house lighting current without the employment of primary or secondary batteries, for which they have obtained Letters Patent of the United States No. 1,455,141, dated May 15, 1923; and Power Amplifiers for Loud Speakers for which they have obtained Letters Patent No. 1,606,212, dated November 9, 1926; and

WHEREAS, P. D. Lowell has filed applications for Letters Patent on January 13, 1925, covering improvements upon the circuits covered by the present patents and Serially Numbered 2214 and 2215;

WHEREAS, F. W. Dunmore is the inventor of certain improvements in Signal Receiving Circuits covered by Letters Patent 1,655,117, dated July 5, 1927;

WHEREAS, under date of October 20, 1924, said P. D. Lowell and F. W. Dunmore entered into an agreement with Jubilier Condenser & Radio Corporation (Licensors name as of October 20, 1924), in which they reserved the right to grant a license under the aforesaid inventions to Brandes Products Corporation; and

WHEREAS, Jubilier Condenser Corporation owns and controls certain inventions relating to the operation of radio receiving apparatus with power derived from the usual alternating current residence lighting circuit for which inventions the following applications for Letters Patent are now pending:

Ser. No.	Title	Inventor	Date
726,841	Thermionic Valves	H. W. Houck	July 18, 1924
736,182	Conductors and Process of Making Same	J. V. Capicotto	Sept. 5, 1924
745,897	Thermionic Valves	H. W. Houck	Oct. 24, 1924
I-[illegible],092	Design for Casings for Electrical Apparatus	H. A. Van Deventer	Oct. 8, 1924
I-[illegible],094	Design for Casings for Electrical Apparatus	E. D. Forbes	Oct. 8, 1924
I-[illegible],095	Design for Casings for Electrical Apparatus	E. D. Forbes	Oct. 8, 1924
I-[illegible],117	Design for Casings for Electrical Apparatus	H. W. Houck	Oct. 18, 1924
745,859	Filtering Arrangement for Direct Current	H. W. Houck	Oct. 24, 1924
745,660	Stacks of Electrical Appliances	H. W. Houck	Oct. 24, 1924
745,661	Apparatus for Filtering Electrical Currents	H. W. Houck	Oct. 24, 1924
745,697	Stacks of Electrical Appliances	H. A. Van Deventer	Oct. 24, 1924
746,437	Containers for Electrical Apparatus	E. D. Forbes	Oct. 28, 1924

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Page 2. PLAINTIFFS' EXHIBIT NO. 101 SHEET 2, 490- 491

Ser. No.	Title	Inventor	Date
14,313	Controlling Means for Rectifying Apparatus	H. J. Van Deventer	Mar. 11, 1925
23,362	Rectifiers	H. W. Houck	Apr. 15, 1925
28,402	Method for Controlling Electrical Power	H. J. Van Deventer	May 6, 1925
32,717	Frequency Changers	H. W. Houck	May 21, 1925
34,914	Electrical Transformers	A. Nyman	June 1, 1925
66,386	Electrical Rectifiers	A. Nyman	Oct. 31, 1925
90,807	A.C. Operated Radio Sets.	A. Nyman	Feb. 26, 1926
95,321	Rectifying and Filtering Apparatus	A. Nyman	Mar. 17, 1926
95,725	Method of Energizing Filaments	A. Nyman & G. V. Peck	Mar. 18, 1926
109,498	Electron Tube Filaments	H. W. Houck	May 17, 1926
109,499	Filter Systems	H. W. Houck	May 17, 1926
109,500	Electrical Filters	H. W. Houck	May 17, 1926
157,487	Rectifiers with Phase-Multiplying Devices	A. Nyman	Sept. 14, 1926

WHEREAS, Dubilier Condenser Corporation owns and controls certain inventions relating to Radio Receiving Circuits particularly straight line frequency tuning condensers for which applications for Letters Patent are pending as follows:

715,627	Condenser	A. Nyman	May 24, 1924
726,368	Variable Condensers	A. Nyman	July 19, 1924
145,028	Condenser	A. Nyman	Oct. 29, 1926

WHEREAS, Licensee is desirous of acquiring a license to manufacture, use and sell apparatus under the aforementioned Letters Patent, and to acquire a license under all of the said inventions covered by the applications for Letters Patent hereinbefore mentioned.

NOW, THEREFORE, for and in consideration of the premises and the covenants hereinafter recited and to be faithfully performed, and the sum of Five Thousand ($5,000.00) Dollars by Licensee to Lowell and Dunmore in hand paid as advance royalties, the receipt of which is hereby acknowledged, it is understood and agreed as follows:

1. Licensors hereby give and grant to the Licensee in accordance with the terms and conditions hereinafter stated, a non-exclusive license under said patents and any patents that may issue on any of the aforesaid applications together with any continuations, division or reissue thereof, to manufacture and to use and sell, (except as hereafter noted but including the right to export to all foreign countries) for the life thereof, unless this agreement be terminated as hereinafter provided, current supply apparatus, power amplifiers, loud speakers, radio receiving sets, battery substitutes, and/or electric phonographs embodying said inventions or any of them, and parts thereof or therefor, except that this license will not be effective to permit Licensee to engage in the manufacture of devices hereunder within ten miles of the territorial limits of the city of Philadelphia, Pennsylvania, and this license will not be effective to permit Licensee to engage in the manufacture of electrical relays actuated by incoming signals.

2. Licensee covenants to pay to Lowell and Dunmore during the life of this

[illegible]	Title	Inventor	Date
14,313	Controlling Means for Rectifying Apparatus	H. J. Van Deventer	Mar. 11, 1925
23,362	Rectifiers	H. W. Houck	Apr. 15, 1925
28,402	Method for Controlling Electrical Power	H. J. Van Deventer	May 6, 1925
32,717	Frequency Changers	H. W. Houck	May 2[illegible], 1925
34,914	Electrical Transformers	A. Nyman	June 1, 1925
66,386	Electrical Rectifiers	A. Nyman	Oct. 31, 1925
80,827	A.C. Operated Radio Sets	A. Nyman	Feb. 26, 1926
86,321	Rectifying and Filtering Apparatus	A. Nyman	Mar. 17, 1926
86,723	Method of Energizing Filaments	A. Nyman & G. V. Peck	Mar. 18, 1926
109,498	Electron Tube Filaments	H. W. Houck	May 17, 1926
109,499	Filter Systems	H. W. Houck	May 17, 1926
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2. Licensee covenants to pay to Lowell and Dunmore during the life of this agreement a minimum annual royalty of Five Thousand ($5,000.00) Dollars, the first of such payments having been made at the execution thereof as hereinbefore recited. Royalty at the rate of Fifty Cents ($0.50) per combined A, B, or C power supply apparatus, radio receiving sets equipped therewith, separate A or B power supply apparatus, loud speakers with power amplifier equipment or any other embodiment of said inventions shall be com-

puted upon each licensed device sold by the Licensee except that in the case of B battery eliminators sold as single units and electric phonographs, the royalty shall be computed at Twenty-five Cents ($0.25) per unit.

3. A maximum royalty per year payable to Lowell and Dunmore is hereby fixed as Seven Thousand Five Hundred Dollars ($7,500.00) to cover all Socket Power Apparatus which may be manufactured under this agreement, that is to say, A, B or C battery eliminators or substitutes, B battery kits, or any combination of these devices, complete radio receiving sets or attachments therefor for operating the receiving apparatus from the usual house lighting circuit without the employment of batteries, power amplifiers, loud speakers and electric phonographs; and the parties hereby acknowledge that no further payments over and above the said Seven Thousand Five Hundred ($7,500.00) Dollars per year shall be required.

4. This license shall extend to all embodiments of the inventions covered by any patent hereunder, that is, for the manufacture, use and sale of A, B, or C battery eliminators or substitutes, B battery kits, or any combination of these devices, complete radio receiving sets or attachments therefor for operating the receiving apparatus from the usual house lighting circuit without the employment of batteries, power amplifiers and loud speakers and electric phonographs, but not electrical relays actuated by incoming signals, and it is specifically understood that no restrictions shall be placed upon the uses to which said apparatus may be put. Only one royalty shall be computed on account of a single complete apparatus such as a combined power operated speaker and power operated receiving set or a separate power operated speaker or a separate power operated receiving set, electric phonograph or other unit apparatus as above set forth; and the Licensee shall not be liable for royalties upon any apparatus returned by purchasers for credit and shall have the right to deduct the amount of any such royalties already computed from the amount of royalties that may subsequently accrue. No royalty shall be paid on spare parts or apparatus that are sold as repairs or furnished as replacements.

5. In order to maintain this license, Licensee covenants to pay to Lowell and Dunmore a minimum royalty of Five Thousand ($5,000.00) Dollars during any year, and if during any year the sale of apparatus units shall not amount to said minimum royalty, Licensee shall be required to pay the deficit or forfeit the right to this license.

6. Licensee covenants to pay the royalties due under this agreement in semi-annual payments on July thirtieth and January thirtieth, the said payments to include all royalties due and payable up to within thirty days of the said dates. Apparatus units shall be considered to be sold and to be included in the royalty report to Licensors when billed and shipped.

7. All royalty payments under this agreement shall be made to Percival D. Lowell and Francis W. Dunmore, at 3411 Scott Street, Northwest, Washington, D. C., unless notified otherwise by the inventors. Dubilier Condenser Corporation agrees to accept in lieu of royalty under this agreement the condenser business of the Licensee for apparatus embodying the subject matter of the inventions herein and agrees to furnish such condensers as it manufactures to Licensee, on Licensee's order. Licensee is not prevented by this agreement from purchasing condensers from other manufacturers up to 56% of Licensee's total annual requirements in dollars value. If purchases are made of other condensers in an amount exceeding 55% of the Licensee's total annual requirements, then the Licensee shall pay to Dubilier Condenser Corporation a sum of $150.00 for every 1% more than 55% so purchased. In figuring the total requirements, the licensee is permitted to exclude from consideration under this restriction clause, only the 55% above mentioned, and/or such condensers ordered, which after acceptance Dubilier Condenser Corporation fails to deliver within the time specified on the licensee's order and licensee does not accept such delivery; providing however, that licensee's delivery requirements are not unreasonable. Accounting to Dubilier Condenser Corporation shall be made at times named in paragraph #6 hereof and payment separate and apart from the payments to Lowell and Dunmore made to Dubilier Condenser Corporation, 4377 Bronx Boulevard, New York City, N.Y.

8. The Licensors agree that in the event that the patent situation under this agreement shall be sold, assigned or extended to Radio Corporation of America, or its associated interests, with the right to extend such protection automatically to licensees of Radio Corporation of America or its associated interests to whom Licensee may be paying royalty on the same apparatus which is being accounted for under this agreement, that Licensors shall stand ready to protect Licensee against the payment of

a double royalty by waiving the payment of royalties under this agreement at the option of the Licensee.

9. Licensors agree to notify Licensee in the event that rights under the patents and the inventions embodied in this agreement may pass automatically to licensees of Radio Corporation of America, or its associated interests, but it is specifically understood that the grant of a license to Radio Corporation of America or its associated interests without the right of automatic extension to licensees of Radio Corporation of America or its associated interests shall not operate to relieve Licensee herein from the payment of royalties to Licensor, and the Licensee shall be held liable for the payment of royalties hereunder up to the date of such extension agreement, if and when, consummated.

10. In the event that Radio Corporation of America or its associated interests, or any other competitive interest acquire Dubilier Condenser Corporation, all parties hereby agree that Brandes Products Corporation may terminate this agreement, and all rights revert to original owners as though this license had not existed.

11. Licensee agrees to keep proper books of account with reference to all apparatus units which it may manufacture and sell embodying the aforesaid inventions, modifications and improvements and shall render semi-annual statements or extracts from said books showing the total amount of such apparatus units as may have been manufactured and sold during the preceding royalty period and the amount of royalty payable, the said statements to be rendered at the time of making the royalty payments designated in paragraphs 5 and 6 hereof.

12. The Licensee is required to mark all apparatus manufactured and sold by it embodying the invention covered by the said Letters Patent 1,455,141, 1,606,212 and 1,635,117 with the number or date of the said patents as well as the number or dates of other patents which may be issued within this agreement.

13. The Licensee hereby admits the validity of the said patents 1,455,141, 1,606,212 and 1,635,117 and agrees that the scope thereof embraces any radio apparatus operated from an alternating current supply in combination with rectifying means wherein the rectified current is used to replace the usual A battery, B battery, or both; and that the patents cover devices commonly termed "A or B battery eliminators" power amplifiers, power operated loud speakers and electric phonographs whether supplied with radio receivers or separate for use therewith.

14. The Licensee hereby covenants and agrees not to contest the validity of said patents 1,455,141, 1,606,212 and 1,635,117, or to aid others to do so in any manner during the life of this agreement or during the pendency of any suit begun during the pendency of this agreement, and to respect the said patents until the final decision of a Court of last resort shall be delivered. If, as a result of such final Court decision or termination of pending interference proceedings, substantial protection for the main subject matter of this agreement is not afforded by said patents, or if adversely held patents are declared to prevent the manufacture of devices under said patents, the Licensee may terminate this agreement if it shall so elect, by giving sixty days written notice to Licensors and paying all royalties due and accrued to the date of termination.

15. The Licensee hereby covenants and agrees to aid and assist Licensors in protecting the said patents during the life of this agreement by bringing to Licensors' attention any cases of manufacture and sale of infringing devices that may come to the Licensee's notice and further covenants and agrees to aid and assist in the prosecution and defense of suits respecting the said patents.

16. In case of the termination of this agreement, for any cause whatsoever, all rights and obligations of the parties hereunder shall cease and they shall have free and unprejudiced rights to prosecution and defense in all matters relating to said patents the same as if this agreement had not been made.

17. If any controversy shall arise between the parties as to the performance of any obligations under this agreement, the matter in controversy shall be submitted, at option of either party, to three arbitrators who shall have power to decide the matter in controversy, and to determine what, if any, amount shall be paid by either party to the other as liquidated damages for any breach of this agreement, and such party agrees to pay to the other any damages that may be assessed by the arbitrators. Upon such contingency, each party shall designate one arbitrator, and these two shall

appoint a third arbitrator. The expense of the arbitration shall be borne by the losing party or apportioned between the parties as the arbitrators may direct.

18. This agreement and the covenants herein contained shall be binding upon and inure to the benefit of the successors and assigns of the Licensors and to the successors in whole of the business of the Licensee, it being expressly understood and agreed that the license hereby granted is otherwise indivisable and non-transferable or non-assignable by the Licensee. All rights under this agreement shall terminate upon insolvency or bankruptcy of Licensee and the rights conveyed thereunder shall not pass as an asset of Licensee under conditions of insolvency.

IN WITNESS WHEREOF, Brandes Products Corporation and Dubilier Condenser Corporation have caused this instrument to be executed by their officers thereunto duly authorized and their corporate seals affixed hereto, and Percival D. Lowell and Francis W. Dunmore have signed and sealed this instrument the day and year first above written.

BRANDES PRODUCTS CORPORATION

By FREDERICK DIETRICH (signed)
President

Attest:

CHAS GILBERT (signed)

DUBILIER CONDENSER CORPORATION

By FRED D. WILLIAMS (signed)
President

Attest:

W. J. SMITH (signed)
Secretary

PERCIVAL D. LOWELL (signed)
Percival D. Lowell

Witness:

HENRY H. HAYHOE (signed)

FRANCIS W. DUNMORE (signed)
Francis W. Dunmore

Witness:

FRANK H. ROBERTS (signed)

STATE OF NEW JERSEY)
) SS:
COUNTY OF ESSEX)

On this 10th day of October, 1927, personally appeared before me FREDERICK DIETRICH, to me known and known to me to be the President of BRANDES PRODUCTS CORPORATION, of Newark, New Jersey, and he duly acknowledged to me that he executed the foregoing instrument on behalf of said Corporation, and that he was fully authorized to do so.

WITNESS my hand and Notarial Seal.

J. HOLLIS HALL (signed)
Notary Public.

STATE OF NEW YORK)
) SS:
COUNTY OF NEW YORK)

On this 5th day of October, 1927, personally appeared before me FRED D. WILLIAMS, to me known and known to me to be the President of the DUBILIER CONDENSER CORPORATION of New York City, and he duly acknowledged to me that he executed the foregoing instrument on behalf of the said Corporation, and that he was fully authorized to do so.

WITNESS my hand and Notarial Seal.

IRMA E. BENNER (signed)
Notary Public.

STATE OF NEW YORK)
) SS:
COUNTY OF QUEENS)

On this 11th day of October, 1927, personally appeared PERCIVAL D. LOWELL, to me known and known to me to be the individual named in and who executed the foregoing instrument, and he duly acknowledged to me that he executed the same of his own free will for the purpose therein set forth.

WITNESS my hand and Notarial Seal.

REYNOLD L. JORDAN (signed)
Notary Public.

CITY OF WASHINGTON)
) SS:
DISTRICT OF COLUMBIA)

On this 30th day of Sept., 1927, personally appeared FRANCIS W. DUNMORE, to me known and known to me to be the individual named in and who executed the foregoing instrument, and he duly acknowledged to me that he executed the same for the purpose therein set forth.

WITNESS my hand and Notarial Seal.

KATHERINE J. TENTON (signed)
Notary Public. D...

PLAINTIFFS' EXHIBIT NO. 102, Sheet 1.
(License to Grigsby-Grunow-Hinds Co. dated Nov. 28, 1927.)

LICENSE AGREEMENT

THIS AGREEMENT made and entered into this 18th day of November, 1927, by and between DUBILIER CONDENSER CORPORATION, a corporation of the State of Delaware, having its principal office at New York City, New York, party of the first part, hereinafter also referred to as DUBILIER CORPORATION, and GRIGSBY-GRUNOW-HINDS COMPANY, an Illinois corporation having its principal office at Chicago, Illinois, party of the second part, hereinafter also referred to as GRIGSBY COMPANY;

WITNESSETH THAT:

WHEREAS, the Dubilier Corporation has the right to grant licenses under United States Letters Patent No. 1,606,212 of November 9, 1926, issued to Francis W. Dunmore and Percival D. Lowell, for Power Amplifier, and the Grigsby Company desires to secure a license to manufacture, use and sell apparatus under said patent;

NOW, THEREFORE, in consideration of the mutual covenants entered into between parties hereto, and the payments herein specified, it is agreed by and between the parties hereto as follows:

(1) The Dubilier Corporation hereby grants to the Grigsby Company, in accordance with the terms and conditions hereinafter stated, a non-exclusive, indivisible license to manufacture, use and sell, for all except wired radio purposes, as hereinafter more fully described, apparatus under United States Letters Patent to Lowell and Dunmore No. 1,606,212 of November 9, 1926, and under any other improvement applications or patents on the apparatus covered by said Lowell and Dunmore patent No. 1,606,212 owned or controlled by the Dubilier Corporation, or under which said corporation may have the right to grant a license.

It is specifically understood that this license shall not extend to Licensee any rights to manufacture or sell apparatus embodying the invention of the aforesaid Letters Patent for wired radio purposes; that is to say, Licensors specifically exclude from the grant herein any right to manufacture, sell or use the apparatus in which the circuits of electron tubes are supplied with power obtained from a power line circuit, such as the home lighting mains, where signals are conveyed directly to the electron tube circuit by carrier currents superimposed on line wire circuits by a transmitter connected to the line wire circuits for the purpose of impressing the carrier currents thereon, where such carrier currents are received by a device connected with the line which receives radio frequency current as a carrier wave over a line circuit, which system is commonly known as wired radio, wired wireless or carrier current line wire transmission. This exception does not apply to the linking of broadcasting stations by wire with a transmitting station where the energy is radiated and subsequently received by space radio receiving apparatus.

(2) The Grigsby Company shall pay to the Dubilier Corporation a royalty of seventy-five (75¢) cents on each complete unit of apparatus manufactured and sold by the Grigsby Company coming under said Lowell and Dunmore patent, or any other application, or patent under which the Grigsby Company may be licensed as specified in paragraph 1.

(3) Said Grigsby Company shall pay such royalties quarterly on the fifteenth (15th) day of the months of January, April, July and October of each year for the preceding three (3) calendar months, and shall submit a report with such payment showing the number of units manufactured and sold for the said period for which payment is being made.

(4) Said Grigsby Company shall pay a minimum annual royalty on not less than five thousand (5000) units per year, the first year to commence with January 1, 1928, and shall not be required to make a maximum payment of royalties of greater than Seventy-five Hundred ($7500.00) Dollars per each year, beginning with January 1, 1928; each quarterly payment to be on a minimum of not less than twelve hundred and fifty (1250) units for the quarter, provided however, that should the Grigsby Company manufacture and sell less than the minimum number during any quarter the excess royalty paid for that quarter over the number actually sold for that quarter shall be credited on the next quarter or any succeeding quarter of that yearly period.

(5) The Grigsby Company shall keep true and accurate records of all units manufactured and sold under this license agreement, and agrees to permit the Lubilier Corporation or its authorized representative to inspect such records at any reasonable time in order to verify the accuracy of any of the reports made by the Grigsby Company hereunder.

(6) Should the Grigsby Company fail to make a report and payment of royalty when due as provided herein, the Lubilier Corporation shall have the privilege of terminating this license to the Grigsby Company upon thirty (30) days' notice, provided however, that should the Grigsby Company make such report and payment before the expiration of the thirty days, then such notice shall be without force and effect and t is license continue as though no notice had been given.

(7) This agreement shall inure to the benefit of and be binding upon the successors and assigns of the parties respectively; it being expressly understood and agreed, however, that the license is indivisible and non-transferable by the Licensee except in connection with said Licensee's entire business and assets. All rights under this Agreement shall terminate upon insolvency or bankruptcy of

Licensee and the rights conveyed hereunder shall not pass as an asset of Licensee under conditions of insolvency.

(8) The Grigsby Company is hereby given the right to terminate the license herein granted by the Dubilier Corporation to the Grigsby Company at the end of any calendar yearly period, beginning with the year 1930, by giving not less than sixty (60) days' notice in writing to the Dubilier Corporation prior to the end of the year of termination.

(9) The Grigsby Company shall place appropriate patent marking on any device or apparatus manufactured and sold under the license herein granted.

(10) It is hereby stipulated and agreed that if the Grigsby Company requires any outside source of supply of "paper condensers" of the type used by the Grigsby Company in its B current Supply Units, the Dubilier Corporation shall have the preference in supplying such condensers to the Grigsby Company, provided the price and quality of the Dubilier condenser shall meet the corresponding price and quality of any other outside source.

In witness whereof the parties hereto have caused this instrument to be executed by their officers hereunto duly authorized and their corporate seals affixed hereto.

DUBILIER CONDENSER CORPORATION

Attest:

By FRED D. WILLIAMS
President.

W J. SMITH
Secretary

GRIGSBY-GRUNOW-HINDS COMPANY

By B. J. Grigsby
President.

Attest:

A. WINNAN
Secretary.

STATE OF NEW YORK)
) SS:
COUNTY OF BRONX)

On this 15th day of November, 1927, personally appeared before me F. D. WILLIAMS, to me known and known to me to be the President of the MUBILIER CONDENSER CORPORATION of New York City, and he duly acknowledged to me that he executed the foregoing instrument on behalf of the said corporation, and that he was fully authorized to do so.

WITNESS my hand and Notarial Seal.

IRMA E. REUNER
Notary Public.

Notary Public, Bronx Co. No.155
Cert.filed in N.Y. Co. No.843
Commission expires Mar. 30, 1929.

STATE OF ILLINOIS)
) SS:
COUNTY OF)

On this 18 day of Nove. 1927, personally appeared before me B. J. GRIGSBY, to me known and known to me to be the President of GRIGSBY-GRUNOW-HINDS COMPANY, of Chicago, Illinois, and he duly acknowledged to me that he executed the foregoing instrument on behalf of said corporation, and that he was fully authorized to do so.

WITNESS my hand and Notarial Seal.

REGINA A. GALLAGHER
Notary Public.

PLAINTIFFS' EXHIBIT NO. 102, Sheet 6, 510-511

Dubilier
Condenser Corporation

4377 Bronx Boulevard at 238 Street
New York

Dec. 8, 1927.

9

Mr. John B. Brady,
Ouray Bldg.,
Washington, D.C.

Dear Mr. Brady,

I have your letter of the 7th. Thanks for writing that you will keep Mr. Edwards posted with copies of all matters pertaining to these patents.

I hope you have good luck on the 12th, as undoubtedly you will.

Regarding my trip West: I got only as far as Chicago, and had to come back, on account of other matters, and will not know for the next few days whether I can go yet this month, or if it will have to be in January, but I anticipate going, just as soon as it can be arranged. I will keep you advised as any developments occur, and on my return from the Coast will give you full report.

Yours very truly,

Fred D. Williams

Fred D. Williams, President
DUBILIER CONDENSER CORPORATION.

FDW/B

PLAINTIFFS' EXHIBIT No. 102, Sheet 7. 512-513

Dubilier
Condenser Corporation

4377 Bronx Boulevard at 238 Street

New York

Dec. 8, 1927.

JOHN B BRADY
RECEIVED
DEC 9 1927
WASHINGTON D.C.

Mr. John B. Brady,
Ouray Bldg.,
Washington, D.C.

Dear Mr. Brady,

As I wrote you some time ago, I have been working with the Grigsby people on the Power Amplifier patent license, and the one we finally agreed upon is herewith attached. I believe you will agree with me this is establishing at least a starting point, and I feel very much gratified I have gotten two licenses with the Grigsby people on the three patents, and I know you feel the same way.

Don't forget that we are working for you boys all the time, and this is a case where they make their own condensers, so you see we have not profited at all in that respect.

Yours very truly,

Fred D. Williams

Fred D. Williams, President
DUBILIER CONDENSER CORPORATION.

FDW/G

514 - 515

Registered

PLAINTIFFS' EX. No. 105. (Letter from Plaintiffs to Defendants dated Aug. 5, 1933 notifying of infringement.)

August 5, 1933

Baltimore Gas Light Company
Baltimore
Maryland

Gentlemen:

Your attention is called to United States Letters Patent No. 1,455,141 granted May 15, 1923, No. 1,606,212 granted November 9, 1926 and No. 1,635,117 granted July 5, 1927.

We are advised that you are selling radio receiving apparatus infringing upon the claims of these patents, an example of such apparatus being the Stewart Warner alternating current operated radio receiving sets.

On behalf of the owners of the above patent rights we write to request you to discontinue the further sale of such apparatus and to make an account of the profits derived by you and the damages caused to the owners of the patent rights by reason of your infringement.

Very respectfully,

CVE:B

[illegible], POWER & POOL

Cy to Mr. John B. Brady

PLAINTIFFS' EXHIBIT NO. 105, Sheet 2. 516- 517

323538

Receipt for Registered Article No.

AUG 1933 REGISTERED

RETURN RECEIPT

Received from the Postmaster the Registered or Insured Article, the original number of which appears on the face of this Card.

Balt Sas

(Signature or name of addressee)

(Signature of addressee's agent)

Date of delivery 8/ , 19

Post Office Department

OFFICIAL BUSINESS

REGISTERED ARTICLE

No. 37

INSURED PARCEL

No.

PENALTY FOR PRIVATE USE TO AVOID PAYMENT OF POSTAGE

POSTMARK

AND DATE OF DELIVERY

Return to Edwards & Brewer & Loop

Street and Number, or Post Office Box, } 63 Wall St

(NAME OF SENDER)

NEW YORK,

NEW YORK.

PLAINTIFFS' EXHIBIT No. 106. Sheet 1.
(Bureau of Standards publication, Oct. 1922, No. 450)

DEPARTMENT OF COMMERCE

SCIENTIFIC PAPERS
OF THE
BUREAU OF STANDARDS

S. W. STRATTON, DIRECTOR

No. 450
[Part of Vol. 18]

AN ELECTRON TUBE AMPLIFIER USING 60-CYCLE ALTERNATING CURRENT TO SUPPLY POWER FOR THE FILAMENTS AND PLATES

BY

P. D. LOWELL, Associate Physicist
Bureau of Standards

OCTOBER 2, 1922

PRICE, 5 CENTS
$1.25 PER VOLUME ON SUBSCRIPTION
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WASHINGTON
GOVERNMENT PRINTING OFFICE
1922

PLAINTIFFS' EXHIBIT No. 106, Sheet 2, 520 - 521

AN ELECTRON TUBE AMPLIFIER USING 60-CYCLE ALTERNATING CURRENT TO SUPPLY POWER FOR THE FILAMENTS AND PLATES.

By P. D. Lowell.

ABSTRACT.

Electron tube amplifiers now form an important part of practically all radio receiving sets except the most simple types. Storage cells, which have heretofore usually been required for operating amplifiers, require constant attention, are bulky and heavy, and have other serious disadvantages. The dry cells, which are often used as a source of plate voltage, have a comparatively short life and are expensive and inconvenient. It would be much more convenient to use an amplifier which could be supplied with power from 110-volt, 60-cycle mains for both filaments and plates.

This paper describes a five-stage amplifier, which operates satisfactorily on 60-cycle supply, for both filaments and plates. This amplifier has three radio-frequency stages and two audio-frequency stages, and uses a crystal detector. A special transformer with five windings is used, the primary being supplied with 110 volts alternating current. The 60-cycle current, when used in an ordinary amplifier circuit, introduces a strong 60-cycle note which offers serious interference. This has been practically eliminated by balancing resistances, grid condensers, and special grid leaks of comparatively low resistance, telephone transformer in the output circuit, and crystal detector instead of electron tube detector. In the final form of the amplifier there is only a slight residual hum, which is not objectionable. The amplification obtained with alternating-current supply was as good as that obtained with the same amplifier used with direct-current supply. The complete unit is light, compact, and portable. For the reception of damped waves, the amplifier as constructed operated most satisfactorily for wave lengths from 200 to 750 meters. This range was determined by the working range of the radio-frequency transformers used. By using suitable radio-frequency transformers, it is expected that the amplifier will be effective for the reception of damped waves and undamped waves as long as 10 000 meters. For the reception of undamped waves, a separate heterodyne should be employed. The paper gives circuit diagrams, and states the values of the condensers, resistors, and inductors used. The paper also describes a method for rectifying the 110-volt alternating-current supply and using it for the field of a loud speaker.

Electron tube amplifiers form an important part of practically all radio receiving sets now, except the most simple types. Such amplifiers are, in fact, necessary to receive distant stations, or when using coil antennas. For good operation, amplifier tubes require for the filament a source of voltage of very constant value (usually about 6 volts), and for the plate a source of voltage of from 40 to perhaps 300 volts. The filament voltage is usually supplied by storage cells and the plate voltage by dry cells. The

ce of these cells in operating condition, especially the lla, is often a source of much difficulty and annoyance. e cells are necessarily bulky and heavy, require constant to maintain proper charge and density of electrolyte, jurious acid or other fumes, and are subject to varia- tage during the period of discharge. The development ifier which can be supplied from the ordinary 110-volt current lighting mains is of considerable practical , since it would eliminate the practical difficulties of storage cells. The amplifier using such alternating- ply has the important advantages of reliability, con- d cheapness both in first cost and operating cost.

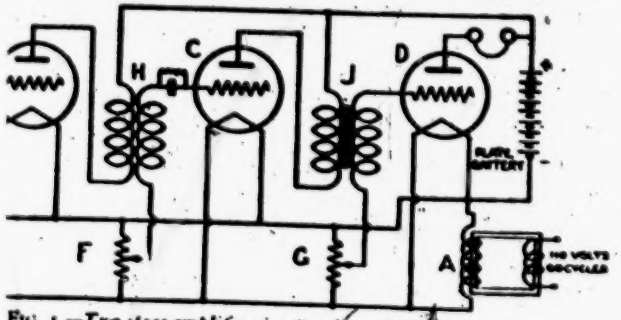


FIG. 1.—*Two stage amplifier circuit using tube detector.*

rnating-current supply the expense of the storage its charging equipment and the expense of the dry he plate are eliminated. The first cost of the ampli- rnating-current supply is somewhat less than the first ordinary amplifier, including its necessary batteries equipment. One of the most important items in the cost of the ordinary amplifier is the dry cells for the , since in service these dry cells must be renewed three to six months. It is estimated that during a years the saving in the cost of "B" dry batteries will a complete amplifier with alternating-current supply. r with alternating-current supply, using five stages n, has been developed at the Bureau of Standards. e stages of radio-frequency amplification and two io frequency amplification. This paper describes briefly.

rangement tried consisted of one radio-frequency ification, tube detector, and one audio-frequency

stage. The filaments of the three tubes were lighted by 6 volts supplied by a step-down transformer, the primary of which was connected to the 110-volt, 60-cycle power mains. The circuit is shown in Figure 1.

In Figure 1, the filament lighting transformer is shown at *A*, supplying voltage for the filaments of electron tubes *B*, *C*, and *D*. The amplifier input circuit is connected to the grid of tube *B* and to the slider of the balancing resistance *E*, the latter having a resistance of 200 ohms and being connected across the filament line. A radio-frequency transformer is shown at *H*, a balancing resistance at *F*, an audio-frequency transformer at *J*, and another balancing resistance at *G*. The purpose of the balancing resistances *E*, *F*, *G*, is to keep the normal voltage of the grids at a steady value with respect to the average voltage of the

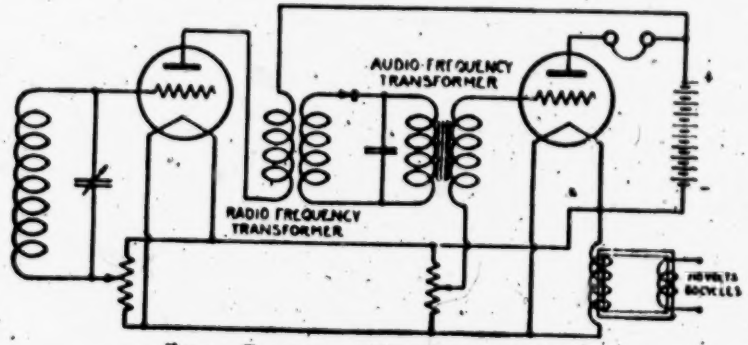


FIG. 2.—*Two-stage amplifier using crystal detector.*

electrical midpoint of the filament, and to thus eliminate the hum which variations of the grid voltage would cause. These balancing resistances are adjusted until the hum is eliminated. Reception was accomplished with this circuit, but there was considerable 60-cycle hum present in spite of the beneficial effect of the balancing resistances.

The employment of a crystal detector in place of the electron tube detector reduced the 60-cycle hum very considerably. This circuit is shown in Figure 2.

When an electron tube is used as the detector, there is impressed on both the plate and the filament a 60-cycle alternating-current voltage which, although small, becomes very objectionable when amplified by one or two stages of audio-frequency amplification. When the crystal detector is used, no 60-cycle voltage is supplied

PLAINTIFF'S EXHIBIT No. 106, Sheet 3,
522-523
762

maintenance of these cells in operating condition, especially the storage cells, is often a source of much difficulty and annoyance. The storage cells are necessarily bulky and heavy, require constant attention to maintain proper charge and density of electrolyte, give off injurious acid or other fumes, and are subject to variations of voltage during the period of discharge. The development of an amplifier which can be supplied from the ordinary 110-volt alternating-current lighting mains is of considerable practical importance, since it would eliminate the practical difficulties of maintaining storage cells. The amplifier using such alternating-current supply has the important advantages of reliability, convenience, and cheapness both in first cost and operating cost.

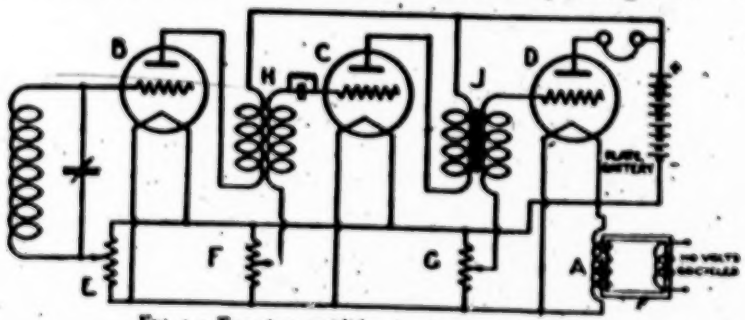


FIG. 1.—*Two stage amplifier circuit using tube detector.*

With alternating-current supply the expense of the storage battery and its charging equipment and the expense of the dry battery for the plate are eliminated. The first cost of the amplifier with alternating-current supply is somewhat less than the first cost of the ordinary amplifier, including its necessary batteries and charging equipment. One of the most important items in the maintenance cost of the ordinary amplifier is the dry cells for the "B" battery, since in service these dry cells must be renewed about every three to six months. It is estimated that during a period of five years the saving in the cost of "B" dry batteries will alone pay for a complete amplifier with alternating-current supply.

An amplifier with alternating-current supply, using five stages of amplification, has been developed at the Bureau of Standards. There are three stages of radio-frequency amplification and two stages of audio frequency amplification. This paper describes this amplifier briefly.

The first arrangement tried consisted of one radio-frequency stage of amplification, tube detector, and one audio-frequency

stage. The filaments of the three tubes were lighted by 6 volt supplied by a step-down transformer, the primary of which connected to the 110-volt, 60-cycle power mains. The circuit shown in Figure 1.

In Figure 1, the filament lighting transformer is shown at supplying voltage for the filaments of electron tubes *B*, *C*, and The amplifier input circuit is connected to the grid of tube *B* a to the slider of the balancing resistance *E*, the latter having resistance of 200 ohms and being connected across the filame line. A radio-frequency transformer is shown at *H*, a balanci resistance at *F*, an audio-frequency transformer at *J*, a another balancing resistance at *G*. The purpose of the balanci resistances *E*, *F*, *G*, is to keep the normal voltage of the gri at a steady value with respect to the average voltage of t

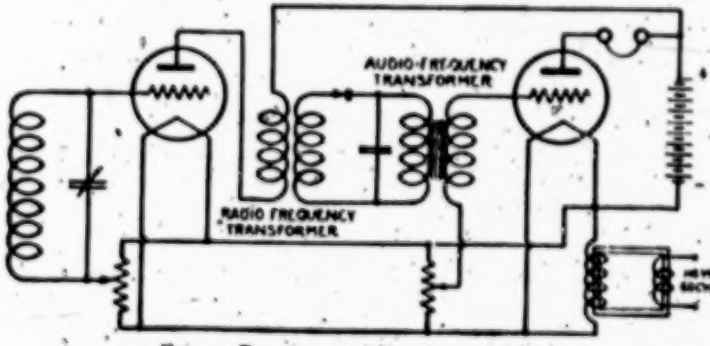


FIG. 2.—*Two-stage amplifier using crystal detector.*

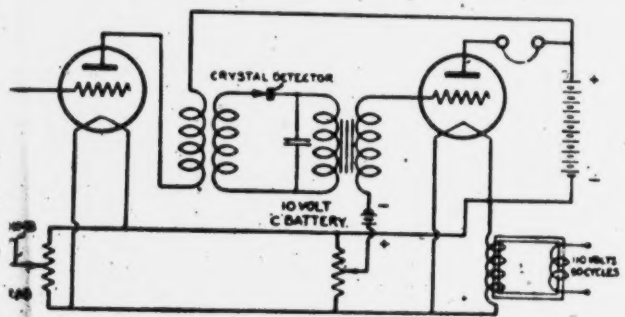
electrical midpoint of the filament, and to thus eliminate the hu which variations of the grid voltage would cause. These balan ing resistances are adjusted until the hum is eliminated. Rece tion was accomplished with this circuit, but there was considera ble 60-cycle hum present in spite of the beneficial effect of t balancing resistances.

The employment of a crystal detector in place of the electr tube detector reduced the 60-cycle hum very considerably. T circuit is shown in Figure 2.

When an electron tube is used as the detector, there is impress on both the plate and the filament a 60-cycle alternating curre voltage which, although small, becomes very objectionable wh amplified by one or two stages of audio-frequency amplificati When the crystal detector is used, no 60-cycle voltage is suppli

ector circuit. The radio-frequency transformer, whose delivered to the detector circuit, prevents the passage preciable amount of 60-cycle current supplied to the ency stage, and such voltages are not present in the ector circuit and do not reach the input of the audio- stage.

loyment of a crystal detector may at first seem objec- ue to the fact that as ordinarily used it is rather difficult oint of good sensitivity. But tests on this amplifier at careful adjustment of the crystal detector was not because of the fact that the radio-frequency amplifi- eding the detector usually gave sufficient signal strength oint of sufficient sensitivity could be easily found.



...ge amplifier using crystal detector, with grid condenser for radio stages and grid battery for audio stages.

ult gave quite good results. The 60-cycle hum was eliminated and the crystal detector gave almost as ation as the tube detector.

und that better amplifying action could be obtained g condensers of about 0.02 microfarad capacity, two megohm grid-leak resistances, in the grid circuits, h the sliders of the balancing resistances. The grid nd grid-leak resistances allow the grids to assume a ge which is more favorable for amplifying purposes. stances allow any accumulated charge on the grids the filaments. Still better amplification and quieter is produced by replacing the series grid condenser and udio stage with a 10-volt battery giving a negative grid. A battery of dry cells was used for this pur- ly an extremely small current is required, the life

of the dry cells is practically their shelf life. This gave a circuit as shown in Figure 3.

Alternating current rectified by means of a gas-filled two-element rectifier tube ("Tungar" tube) was tried as a source of filament power, but the residual hum was much greater than when unrectified alternating current was used. This is because of the fact that during rectification the wave form becomes distorted and it becomes impossible to stabilize the grid voltage by means of the balancing resistances.

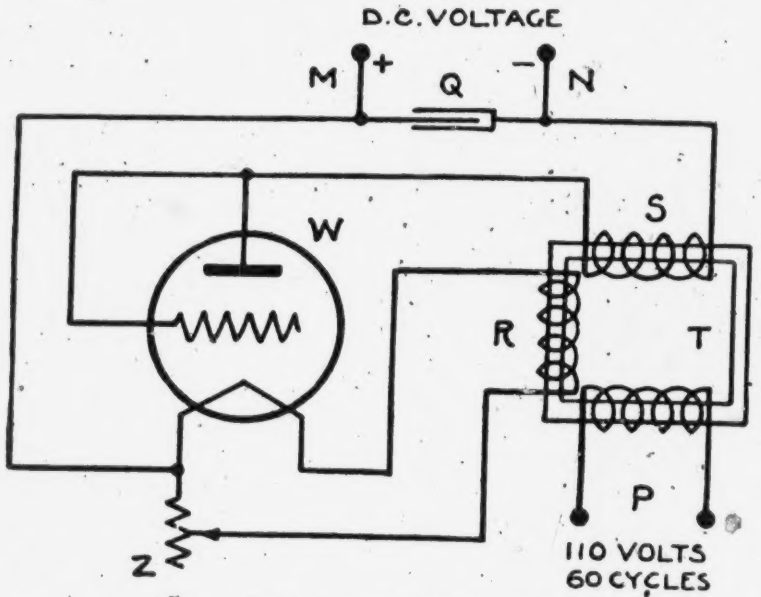


FIG. 4.—*Rectification circuit for plate voltage supply.*

In the above-mentioned tests, a plate battery was used for convenience, but this was replaced by alternating current which had been rectified by means of an electron tube and smoothed out with condensers of large capacity. The rectification circuit for the plate voltage supply is shown in Figure 4.

In Figure 4, the primary P of the transformer T is connected to the power mains, and the winding R gives 8 volts for the filament of the rectifier tube W. Winding S gives 300 volts which is rectified by the tube W and smoothed out by the condenser Q which has about 10 microfarads capacity. This gives at terminals M and N a high-voltage direct current which is quite suitable for

PLAINTIFFS' EXHIBIT NO. 106, Sheet 4,
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to the detector circuit. The radio-frequency transformer, whose output is delivered to the detector circuit, prevents the passage in any appreciable amount of 60-cycle current supplied to the radio-frequency stage, and such voltages are not present in the crystal detector circuit and do not reach the input of the audio-frequency stage.

The employment of a crystal detector may at first seem objectionable, due to the fact that as ordinarily used it is rather difficult to find a point of good sensitivity. But tests on this amplifier showed that careful adjustment of the crystal detector was not necessary because of the fact that the radio-frequency amplification preceding the detector usually gave sufficient signal strength so that a point of sufficient sensitivity could be easily found.

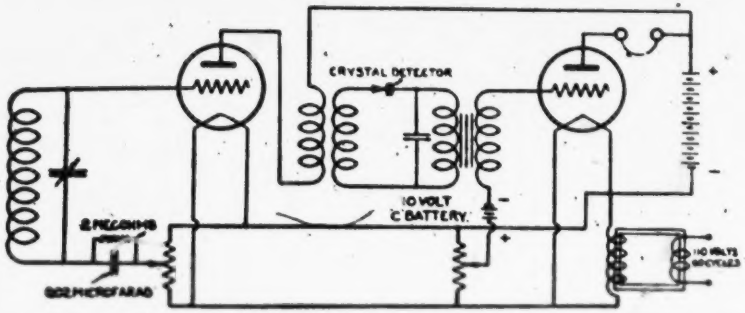

FIG. 3.—*Two-stage amplifier using crystal detector, with grid condenser for radio stage and grid battery for audio stages.*

This circuit gave quite good results. The 60-cycle hum was practically eliminated and the crystal detector gave almost as good rectification as the tube detector.

It was found that better amplifying action could be obtained by inserting condensers of about 0.02 microfarad capacity, shunted by two megohm grid-leak resistances, in the grid circuits, in series with the sliders of the balancing resistances. The grid condensers and grid-leak resistances allow the grids to assume a normal voltage which is more favorable for amplifying purposes. The leak resistances allow any accumulated charge on the grids to leak off to the filaments. Still better amplification and quieter operation was produced by replacing the series grid condenser and leak in the audio stage with a 10-volt battery giving a negative charge to the grid. A battery of dry cells was used for this purpose; since only an extremely small current is required, the life

of the dry cells is practically their shelf life. This gave a circuit shown in Figure 3.

Alternating current rectified by means of a gas-filled two-element rectifier tube ("Tungar" tube) was tried as a source of filament power, but the residual hum was much greater than when unrectified alternating current was used. This is because of the fact that during rectification the wave form becomes distorted and it becomes impossible to stabilize the grid voltage by means of the balancing resistances.

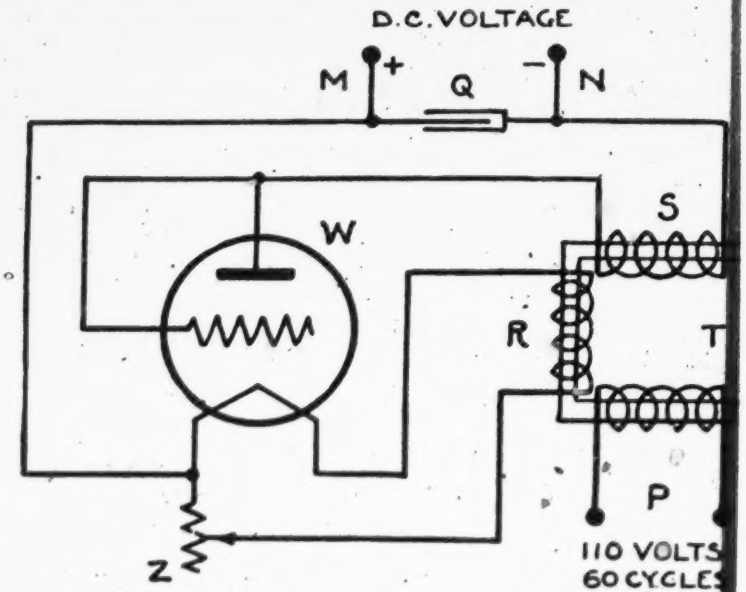

FIG. 4.—*Rectification circuit for plate voltage supply.*

In the above-mentioned tests, a plate battery was used for convenience, but this was replaced by alternating current which had been rectified by means of an electron tube and smoothed out by condensers of large capacity. The rectification circuit for the plate voltage supply is shown in Figure 4.

In Figure 4, the primary *P* of the transformer *T* is connected to the power mains, and the winding *R* gives 8 volts for the filament of the rectifier tube *W*. Winding *S* gives 300 volts which is rectified by the tube *W* and smoothed out by the condenser *Z* which has about 10 microfarads capacity. This gives at terminals *M* and *N* a high-voltage direct current which is quite suitable

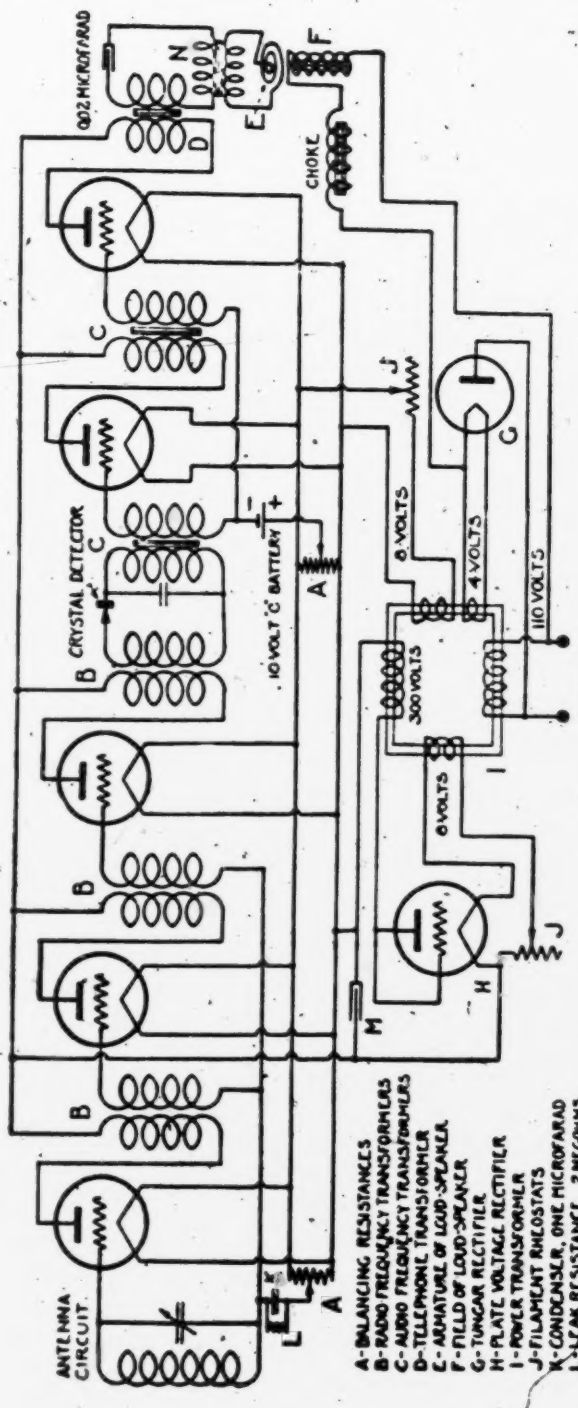

FIG. 5.—*Final complete circuit of five-stage amplifier, using crystal detector and two-cycle alternating current to supply power for the filaments and plates.*

PLAINTIFFS' EXHIBIT NO. 106, Sheet 6,

FIG. 6.—*Complete assembled amplifier unit and rectifier unit, showing connection for 60-cycle a-c supply.*

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PLAINTIFFS' EXHIBIT NO. 106, Sheet 7,

use on the plates of the amplifier tube. Rheostat Z varies the brilliancy of the filament of the rectifier tube and, simultaneously, the voltage for the plates.

The use of a loud-speaking telephone receiver, such as the "Magnavox," was made possible by applying to the field coil of the loud speaker an alternating current rectified by a "Tungar" rectifier tube. The impedance of the field coil was sufficient to smooth out the pulsating current to such an extent that the hum was not annoying. It was also advantageous to couple the loud-speaking reproducer circuit to the plate circuit of the last amplifier tube by means of a one-to-one ratio telephone transformer with a 0.02 microfarad condenser in series with the telephone circuit. This helped considerably to reduce the residual hum in the telephone.

The final circuit is shown in Figure 5, and includes three stages of radio-frequency amplification, galena crystal detector, two stages of audio-frequency amplification, loud-speaking reproducer, and the necessary power transformer and rectification circuits.

This final circuit gives good amplification, with a slight residual hum, which is not great enough to be objectionable when receiving signals of ordinary readable strength. The residual hum is, of course, more objectionable when extremely weak signals are being received. Radiotelephone music and conversation are clearly reproduced.

The amplifier was operated under normal conditions, using the usual sources of direct-current supply, and then switched over to alternating-current supply. This comparative test showed the alternating-current supply to give as good amplification as the direct-current supply, although the set was slightly more sensitive to weak signals when batteries were used, on account of the interference caused by the hum when used on alternating-current.

For the reception of damped waves, the amplifier as constructed operated most satisfactorily for frequencies from 400 kilocycles to 1500 kilocycles per second (750 to 200 meters). This frequency range was determined by the working range of the radio-frequency transformers used. By using suitable radio-frequency transformers, it is expected that the amplifier will be effective for the reception of damped waves for frequencies as low as 30 kilocycles (10 000 meters). This amplifier has also been found effective for the reception of undamped waves, when used with a separate heterodyne.

PLAINTIFFS' EXHIBIT NO. 106, Sheet 8, 532-533

The special transformer with five windings and the rectifier tube were assembled in one box, and the amplifier tubes and amplifier transformers and other apparatus were assembled in a separate box. This was done to avoid having the amplifier immediately adjacent to the special transformer, from which it would pick up considerable 60-cycle hum. The assembled rectifier unit measured about 8 by 8 by 9 inches and weighed about 21 pounds. The assembled amplifier unit measured about 8 by 11 by 14 inches and weighed about 21 pounds.

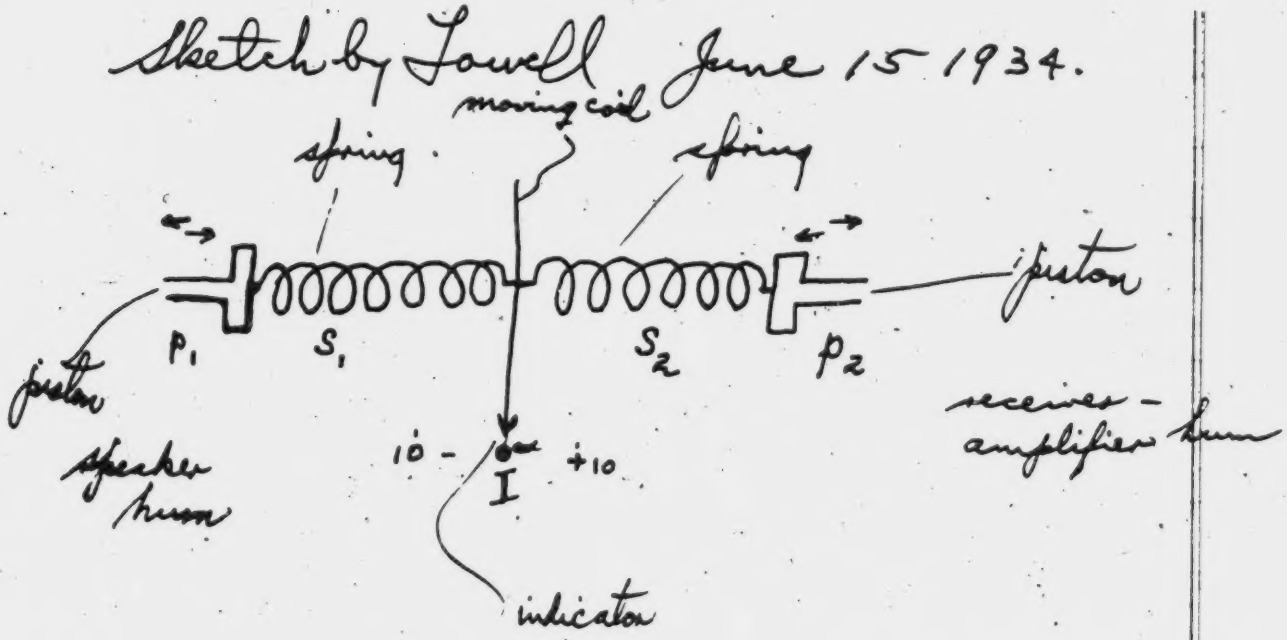
Figure 6 shows the rectifier unit and the amplifier unit as completed, with the plug to connect with the 60-cycle lighting current. A 6-inch rule is shown leaning against the rectifier unit.

F. W. Dunmore was a coworker and participated in the development of this instrument.

WASHINGTON, June 17, 1922.

PLAINTIFFS' EXHIBIT NO. 107,

(Copy of spring analogue diagram drawn on blackboard by witness Lowell).



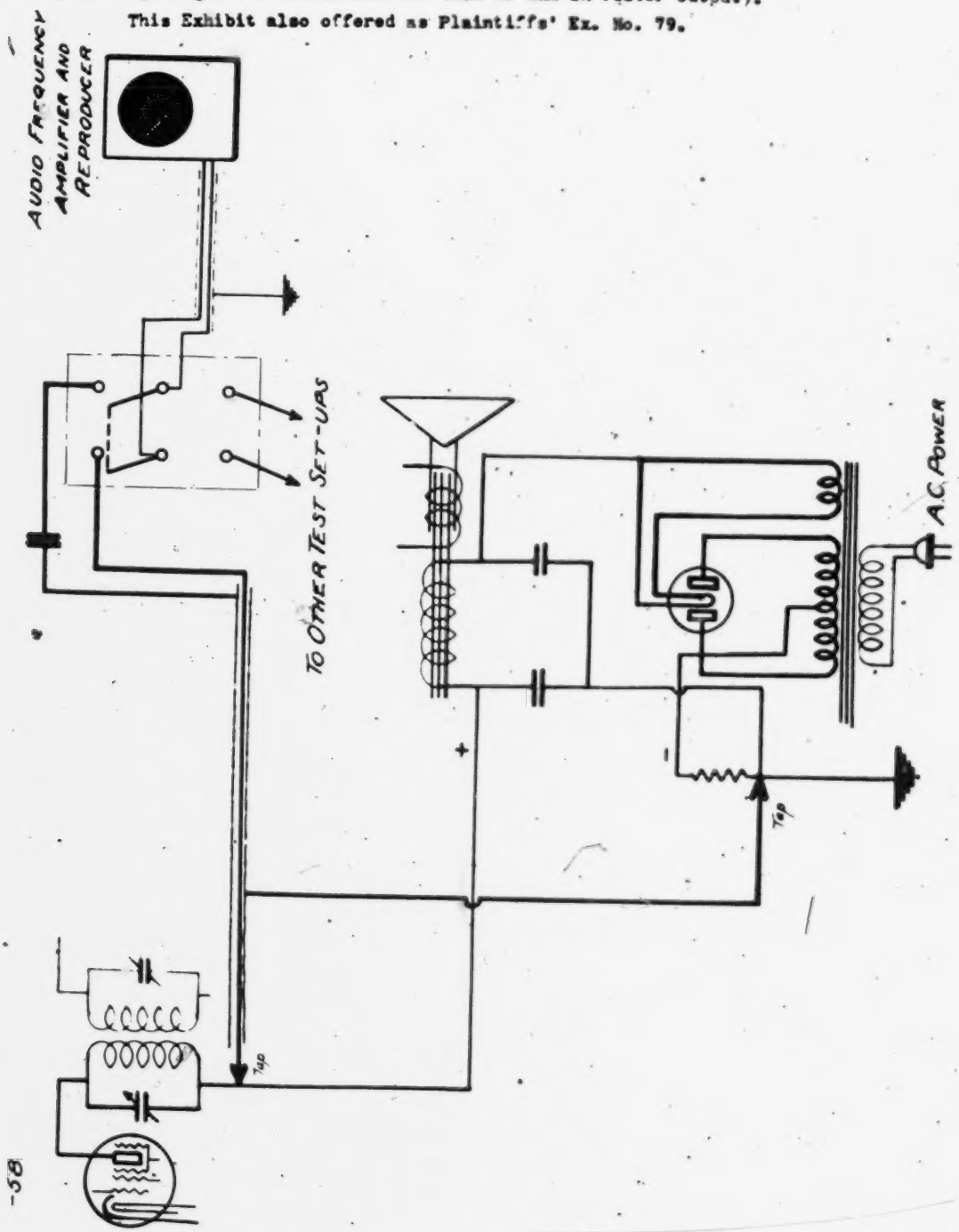
Plaintiff's 107

STEWART – WARNER MODEL 109 – ARRANGED FOR TEST AT OUTPUT OF MAIN FILTER

PLAINTIFFS' EXHIBIT No. 109,

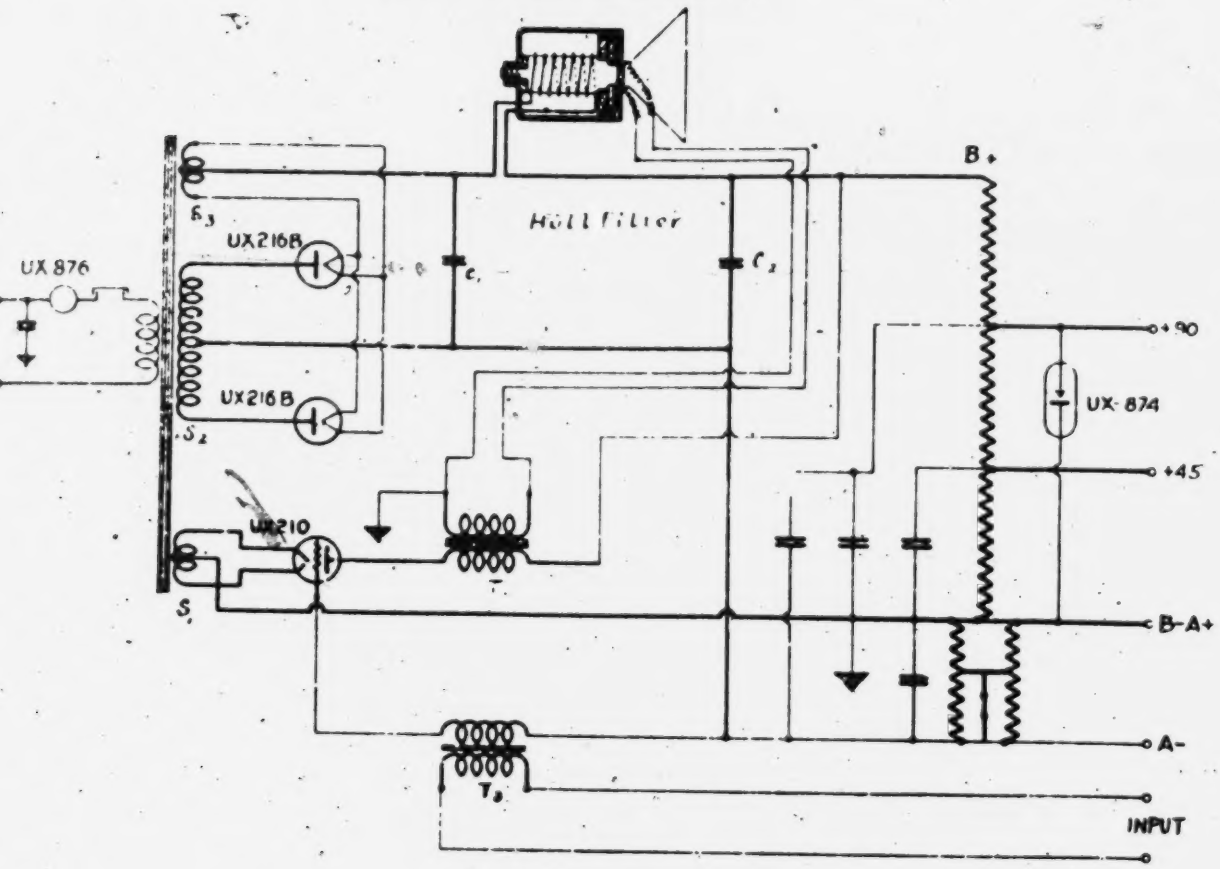
(Wiring diagram of connection for test of hum in filter output).

This Exhibit also offered as Plaintiffs' Ex. No. 79.



DEFENDANTS' EXHIBIT "A",
(Wiring diagram of RCA loudspeaker 104).

SCHEMATIC DIAGRAM
LOUD SPEAKER MODEL 104



DEFENDANTS' EXHIBIT "B"

(Patent 1,282,439 to Langmuir)

I. LANGMUIR.

SYSTEM FOR AMPLIFYING VARIABLE CURRENTS.

APPLICATION FILED OCT. 29, 1913.

771 **1,282,439.** Patented Oct. 22, 1918.

Fig. 1.

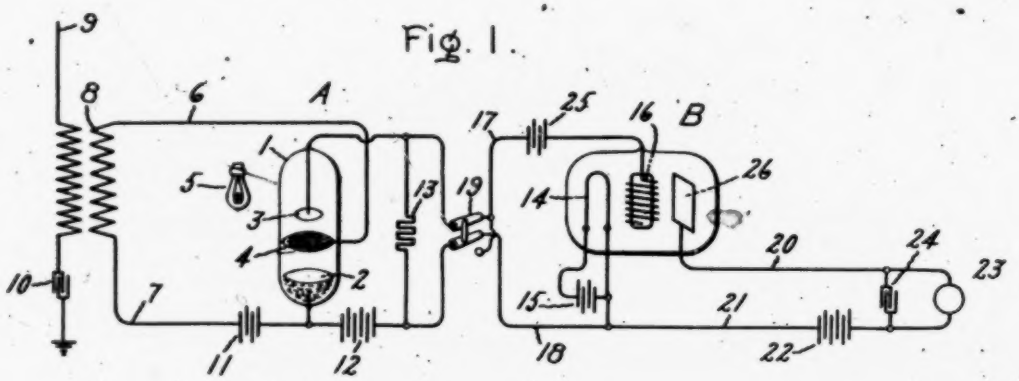


Fig. 2.

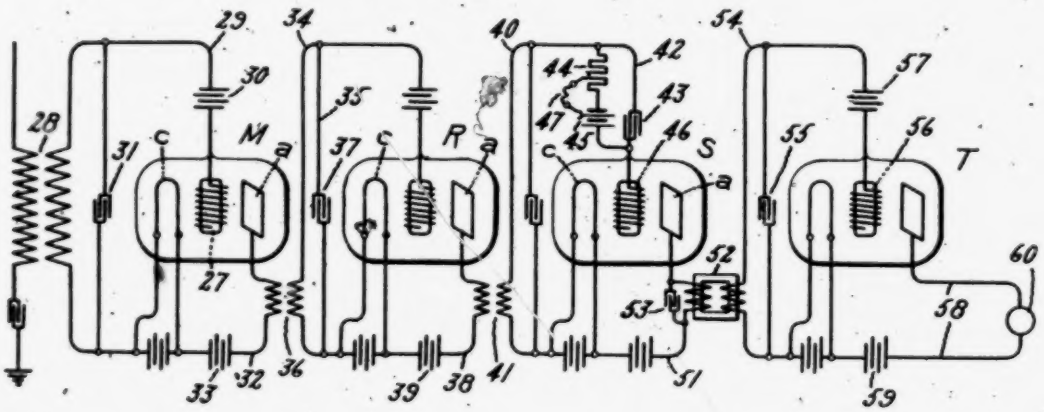
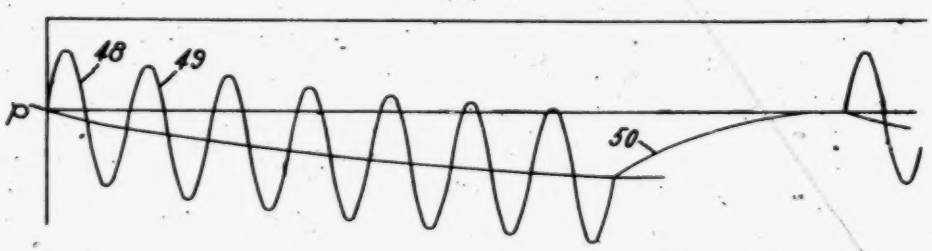


Fig. 3.



WITNESSES:
J. Earl Ryan
J. Ellis Glen

INVENTOR:
IRVING LANGMUIR,
BY Albert G. Davis
HIS ATTORNEY.

UNITED STATES PATENT OFFICE. 772

IRVING LANGMUIR, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

SYSTEM FOR AMPLIFYING VARIABLE CURRENTS.

1,282,439. Specification of Letters Patent. Patented Oct. 22, 1918.

Application filed October 29, 1913. Serial No. 797,985.

To all whom it may concern:

Be it known that I, IRVING LANGMUIR, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Systems for Amplifying Variable Currents, of which the following is a specification.

The present invention relates to electrical discharge apparatus utilizing an electron discharge and comprises novel systems of connection whereby weak variable currents may be reproduced as stronger currents. My invention also includes means for securing selectivity in detecting signals, for example, for receiving systems in radio-telegraphy.

The electron-discharge device preferably utilized in accordance with my invention comprises an incandescent, or other electron-emitting cathode, a coöperating gas-free anode and a discharge-controlling conductor, commonly called the grid, and an inclosing envelop, the space in the envelop being evacuated below the pressure at which appreciable gas ionization by collision with electrons can occur, as described and claimed in my prior application, Serial No. 795,610 filed Oct. 16, 1913, but it is to be understood that my invention is not limited to this particular apparatus.

My invention includes a combination of two or more electron discharge devices connected in cascade, the electrode circuit of one device being connected to a resistance, a reactance or transformer across which is connected the grid circuit of a second device. My invention also includes other novel features, such as means for integrating high frequency wave trains into impulses or waves of lower frequency, tuning both for group frequency as well as wave frequency, and other features pointed out with greater particularity in the appended claims.

A more detailed understanding of my invention may be had from the following description taken in connection with the accompanying drawings, which show for the purpose of illustration my invention as applied to receiving systems of wireless telegraphy. Figure 1 illustrates a system containing a device having an illuminated cathode; Fig. 2 illustrates a tuned system containing a condenser for integrating oscillations, and Fig. 3 is a diagram illustrating an integrating effect secured with a condenser with the grid circuit.

In Fig. 1 an electron discharge device A comprises a gas-tight envelop 1 which may consist of quartz or glass, preferably material pervious to ultra-violet light, and into which are sealed in the usual manner an electron emitting cathode 2, a coöperating anode 3 and a discharge-controlling grid 4 ordinarily located between the cathode and anode. The cathode in this case consists of potassium, sodium, or other metal which emits electrons when illuminated by means of a source of light 5, which may be an incandescent lamp as illustrated or a suitable arc lamp. A monochromatic source of light, such as mercury vapor arc in a quartz or glass envelop is advantageous in giving electrons of uniform velocity. The anode preferably consists of tungsten and is deprived of gas by electron bombardment during the exhausting process, the envelop being sealed when the anode has been thoroughly freed from gas and the pressure in the envelop has been reduced to a value at which no appreciable gas ionization can occur. The grid 4 and the cathode 2 are connected respectively by conductors 6 and 7 to the secondary of a transformer 8, the primary of which is located in circuit with an antenna 9. In the antenna circuit there may be located a grounded condenser 10 but the antenna connections and structure may be the usual ones forming no part of my present invention. In the grid circuit 7, there is preferably included a source of potential 11, such as a battery which preferably is connected to maintain the grid at a definite negative potential, but in some cases the grid may be maintained at a positive potential.

In the circuit connecting the cathode and the anode, also known as the "plate circuit," is included a local source of energy, such as a battery 12, having its negative terminal connected to the cathode, and also a resistance 13. In place of this resistance a sufficiently high inductance may be used, its value depending on the frequency. The grid consists of a frame-work upon which is wound preferably very fine wire, for example, wire having a diameter of about .0004 inch, the turns being closely spaced. To the terminals of the resistance is connected a second electron-discharge device B, having

a cathode 14, adapted to be heated to incandescence by means of a battery 15, or other convenient source. The grid 16 and the cathode 14 are connected to the resistance 13 respectively by conductors 17 and 18, through a reversing switch 19. In the electrode circuit 20, 21, of the device B is included a local source of energy 22 and an electrical detecting device 23, such as any of the known forms of electromagnetic recorders or a telephone. In shunt therewith may be placed a condenser 24. In some cases a battery 25 or other source of potential may be included in the grid circuit 17. This method of connecting two amplifiers in cascade is claimed in my application, Serial No. 11,512, filed March 2, 1915, which is a division of this application.

In the system described the discharge device A, which may have relatively large distances between the grid and the electrodes, is made very sensitive to changes of grid voltages. The fact that the electrons are emitted by the cathode at uniform velocity contributes to its sensitiveness. A comparatively feeble impulse received from the antenna 8 will be accompanied by a change in the current from the local source 12 through the resistance 13. The current increases when a positive wave is superimposed on the negative grid potential. The current flowing through the resistance 13 will be greater than the current received from the antenna, and therefore, will produce greater variations in the static charge of the grid 16 of the device B than were originally received by the grid 4 of the device A. Hence, these potentials may be used to produce greatly amplified signal current. In other words, the stronger currents flowing in the electrode circuit of the device A can be used to vary the flow of electron discharge current between the cathode 14 and the anode 26 of the discharge device B which is adapted to control relatively a greater amount of energy than the device A although not necessarily so sensitive to minute voltage changes as the device A. This feature of my invention is claimed in my application Serial No. 254,334, filed Sept. 16, 1918, which is a division of this application. When the switch 19 is set so as to connect the positive terminal of the resistance 13 to the grid circuit 17, containing means for making the grid 16 negative, an increase of plate current of device A will produce an increase in the plate current of device B. The converse is the case when the connections are reversed. The variations in the electrode or plate circuit constitutes further amplification of the original signal currents and may be made great enough to operate an electromagnetic instrument 23, such as a telegraph relay, or in any convenient way as to indicate the signals. In some cases an ordinary telephone may be connected to the terminals of the conductors 20, 21, to detect the amplified signals.

The system shown in Fig. 2 is in some respects similar to the system shown in Fig. 1, for example, in the character of the discharge device used, and therefore need not be again described in detail. Each device has a heated cathode *c* and an unheated anode *a*, both of which may consist of tungsten. In the system shown in Fig. 2 a number of discharge devices have been shown connected in cascade and one of the devices is provided with means for integrating the high frequency oscillations of the wave trains so as to transmit in its plate circuit variable current which when transformed to an alternating current will correspond in frequency with the group frequency of the wave trains. Such a system permits progressive tuning in each grid circuit whereby the receiving system will select only signals having both a predetermined oscillation frequency and group frequency. This method of operation will be better understood by first considering the connections and then tracing through the method of operation.

The grid 27 of the discharge tube M is connected to the secondary of the loosely coupled air core transformer 28. The primary of the transformer is included in a grounded antenna circuit similar to that shown in Fig. 1. In the grid circuit 29 is included a source of potential 30 and across the transformer secondary is connected a condenser 31, which preferably is made adjustable. By properly proportioning the inductance of the transformer secondary and the capacity of the condenser, the oscillating circuit constituted thereby may be made resonant to a desired frequency and therefore will be largely opaque to disturbances. Hence the grid will be influenced only to a slight extent by frequencies differing from the desired predetermined frequency. As already explained the variations in the grid potential, which is preferably negative, produced by the impressed oscillations result in oscillations in the plate circuit 32 similar to those in the grid circuit. These oscillations having been produced by a local source of current 33 may be stronger than the received oscillations. They are impressed on another oscillating circuit 34, 35, by means of an air core transformer 36. The circuit 34, 35, is likewise adjusted to be opaque to undesired oscillations by properly adjusting the condenser 37. The oscillations produced in the plate circuit 38 of the device R by a local source of energy 39 are again transmitted to another local oscillating circuit 40 which is also tuned, by an air core transformer 41. It will be noted that by thus tuning successive circuits the undesired oscillations are reduced in each case in geometric proportion. This progres-

a cathode 14, adapted to be heated to incandescence by means of a battery 15, or other convenient source. The grid 16 and the cathode 14 are connected to the resistance 13 respectively by conductors 17 and 18, through a reversing switch 19. In the electrode circuit 20, 21, of the device B is included a local source of energy 22 and an electrical detecting device 23, such as any of the known forms of electromagnetic recorders or a telephone. In shunt therewith may be placed a condenser 24. In some cases a battery 25 or other source of potential may be included in the grid circuit 17. This method of connecting two amplifiers in cascade is claimed in my application, Serial No. 11,512, filed March 2, 1915, which is a division of this application.

In the system described the discharge device A, which may have relatively large distances between the grid and the electrodes, is made very sensitive to changes of grid voltages. The fact that the electrons are emitted by the cathode at uniform velocity contributes to its sensitiveness. A comparatively feeble impulse received from the antenna 8 will be accompanied by a change in the current from the local source 12 through the resistance 13. The current increases when a positive wave is superimposed on the negative grid potential. The current flowing through the resistance 13 will be greater than the current received from the antenna, and therefore, will produce greater variations in the static charge of the grid 16 of the device B than were originally received by the grid 4 of the device A. Hence, these potentials may be used to produce greatly amplified signal current. In other words, the stronger currents flowing in the electrode circuit of the device A can be used to vary the flow of electron discharge current between the cathode 14 and the anode 26 of the discharge device B which is adapted to control relatively a greater amount of energy than the device A although not necessarily so sensitive to minute voltage changes as the device A. This feature of my invention is claimed in my application Serial No. 254,334, filed Sept. 16, 1918, which is a division of this application. When the switch 19 is set so as to connect the positive terminal of the resistance 13 to the grid circuit 17, containing means for making the grid 16 negative, an increase of plate current of device A will produce an increase in the plate current of device B. The converse is the case when the connections are reversed. The variations in the electrode or plate circuit constitutes further amplification of the original signal currents and may be made great enough to operate an electromagnetic instrument 23, such as a telegraph relay, or in any convenient way to indicate the signals. In some cases an ordinary telephone may be connected to the terminals of the conductors 20, 21, to detect the amplified signals.

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The grid 27 of the discharge tube M is connected to the secondary of the loosely coupled air core transformer 28. The primary of the transformer is included in a grounded antenna circuit similar to that shown in Fig. 1. In the grid circuit 29 is included a source of potential 30 and across the transformer secondary is connected a condenser 31, which preferably is made adjustable. By properly proportioning the inductance of the transformer secondary and the capacity of the condenser, the oscillating circuit constituted thereby may be made resonant to a desired frequency and therefore will be largely opaque to disturbances. Hence the grid will be influenced only to a slight extent by frequencies differing from the desired predetermined frequency. As already explained the variations in the grid potential, which is preferably negative, produced by the impressed oscillations result in oscillations in the plate circuit 32 similar to those in the grid circuit. These oscillations having been produced by a local source of current 33 may be stronger than the received oscillations. They are impressed on another oscillating circuit 34, 35, by means of an air core transformer 36. The circuit 34, 35, is likewise adjusted to be opaque to undesired oscillations by properly adjusting the condenser 37. The oscillations produced in the plate circuit 38 of the device R by a local source of energy 39 are again transmitted to another local oscillating circuit 40 which is also tuned, by an air core transformer 41. It will be noted that by thus tuning successive circuits the undesired oscillations are reduced in each case in geometric proportion. This progres-

sive tuning thus produced in my present invention is described and claimed in its broad aspect in a patent of Ernst F. W. Alexanderson, No. 1,173,079.

In the present case, I secure as a novel feature tuning for both oscillation frequency and group frequency, as will be explained. The grid circuit 42 of the discharge tube S contains a condenser 43 which is shunted by a high resistance 44 and battery 45 which preferably has its negative terminal connected to the grid 46. Both the resistance and the battery are provided with an adjustable shunt 47 so that the potential of the battery and amount of resistance may be both varied or, in fact, entirely eliminated. Even when the grid 46 is not maintained at a predetermined potential it will assume some negative potential as it receives electrons from the cathode *c* and its potential is determined by the surface of the grid 46 and the rate at which the charge may leak off from the condenser plates. When the grid is positively charged it will take up electrons at a rate varying with the degree of positive charge and, when the grid is negatively charged the rate at which it absorbs electrons decreases with the degree of negative charge until a value is reached at which no more electrons are taken up. The condenser charge will come to an equilibrium when the rate of leakage is equal to the rate of charging by the electrons absorbed. This grid potential may be assumed to have a negative value represented by the line *p* in Fig. 3 which represents a diagram in which the ordinates are grid potentials and the abscissæ represent time. The actual number of oscillations in each group, of course, will be much greater than indicated in Fig. 3. When the oscillations are superimposed on the grid, assuming its potential to be *p*, Fig. 3, a positive wave 48 will cause it to take up more electrons, which are not discharged during the succeeding negative wave. Each successive wave adds its increment to the negative charge which thus accumulates on the grid and the plate of the condenser connected to it. After a certain number of oscillations have thus been received the grid has received such a negative charge that it no longer takes up more electrons than it loses. When the wave train ceases, the added negative charge leaks off as indicated by the line 50, until the grid potential again assumes its original value *p*. The capacity of the condenser 43, the potential of the battery 45, if one is used, and the resistance 44 should be so chosen that the grid 46 will have resumed its equilibrium charge before the next wave train is impressed on it.

As the current in the plate circuit 51 of the tube S is determined by the grid charge, a variable current will tend to flow therein having a frequency equal to the group frequency of the signals received from the antenna and also having a high frequency component. The high frequency component of this current may be eliminated by making the circuit responsive or resonant only to the low frequency. This may be done by providing the transformer 52 with an iron core as to introduce considerable inductance into the circuit 51 and also by shunting the primary circuit of the transformer with a condenser 53. A relatively smooth low frequency alternating current will flow in the secondary circuit 54 which may be tuned for the frequency to be selected by an adjustable condenser 55.

The selectivity of the system thus is made very great as it is opaque not only to disturbances having a different frequency than the oscillations to be received but is also opaque to aerial signals having a different group of frequency. The number of circuits connected thus in series or in cascade may be increased to any desired number.

In the system illustrated the oscillations of the circuit 54 are impressed on a grid 56, in circuit with which preferably is a source of potential 57. The currents in the plate circuit 58 produced by a local source 59 are varied as already explained by variations of grid potential. The amplified and selected signals may be recorded or detected by any suitable form of device as indicated at 60.

The grids of tubes M and R may consist of fine wire, closely spaced, the grid of the device S of coarse wire, more widely spaced, and the grid 56 of tube T of fine wire widely spaced but these relations are not essential.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. A selective system for detecting signals consisting of groups of high frequency oscillations, comprising the combination of a plurality of circuits resonant to the frequency of the oscillations to be selected, relay means interposed between said respective circuits and operative to impress upon one circuit oscillations proportionate to oscillations in another circuit, means for integrating the high frequency oscillations in one of said circuits to produce a variable current having a frequency equal to the group frequency of the signals, a circuit connected thereto resonant to said group frequency and means for detecting current in said circuit.

2. A selective system for detecting signals consisting of a group of high frequency oscillations comprising a plurality of circuits, electron discharge devices connected to link said circuits in cascade, a local source of energy in circuit with each of said discharge devices, a series condenser included in the grid circuit of one of said discharge devices and means for detecting current in

the electrode circuit of the last discharge device of the series.

3. The combination of an electron discharge device having an electron-emitting cathode, a coöperating anode and a conducting body located near said cathode for controlling the electron discharge, a condenser connected in circuit with said body, a high resistance connected in shunt with said condenser and a local source of energy connected in circuit with the electrodes of said device.

4. The combination of a device operating with a substantially pure electron discharge, a grid for controlling the electron discharge, a condenser in circuit with said grid, a circuit shunting said condenser, a resistance and a battery in said circuit, means for varying the potential of said battery and amount of said resistance, and a local source of energy in the electrode circuit of said device.

5. A system for selecting groups of high frequency oscillations from disturbing oscillations comprising the combination of a circuit resonant to the frequency of the oscillations to be selected, a second circuit resonant to the group frequency of said oscillations, relay means interposed between said circuits operative to impress upon the second circuits amplified oscillations proportionate to oscillations in the first circuit and means for receiving and detecting a current in the second circuit.

6. The combination of an electron discharge device having an electron-emitting cathode, a coöperating anode and a grid for controlling the electron discharge, a condenser connected in circuit with said grid and a high resistance connected in shunt to said condenser.

7. The combination of an electron discharge device having an electron emitting cathode, a coöperating anode and a grid for controlling the electron discharge, a condenser connected in series relation in the grid circuit of said device, and a source of potential connected in shunt to said condenser.

8. The combination of an electron discharge device having an electron-emitting cathode, a coöperating anode and a grid for controlling the electron discharge, a condenser in circuit with said grid and a circuit shunting said condenser, said circuit comprising a source of potential and a high resistance.

9. The combination of an electron discharge device having an electron emitting cathode, a plate anode, and a grid inclosed in a receptacle evacuated to such a degree that the device will operate with substantially no gas ionization, grid and plate circuits for said device, means for impressing upon the grid circuit groups of high frequency oscillations, and means for integrating the high frequency oscillations to produce in the plate circuit a variable current having a frequency equal to the group frequency of the high frequency oscillations.

10. The combination of an electron discharge device having an electron emitting cathode, an anode and a grid inclosed in a receptacle evacuated to such a degree that the device will operate with substantially no gas ionization, a condenser connected in circuit with said grid, and a high resistance connected in shunt to said condenser.

In witness whereof, I have hereunto set my hand this 27th day of October, 1913.

IRVING LANGMUIR.

Witnesses:
SAUL DUSHMAN,
HELEN ORFORD.

DEFENDANTS' EXHIBIT "C"

(Patent 1,251,377 to Hull)

A. W. HULL.

METHOD OF AND MEANS FOR OBTAINING CONSTANT DIRECT CURRENT POTENTIALS.

APPLICATION FILED DEC. 22, 1915.

1,251,377. Patented Dec. 25, 1917.

Fig. 1.

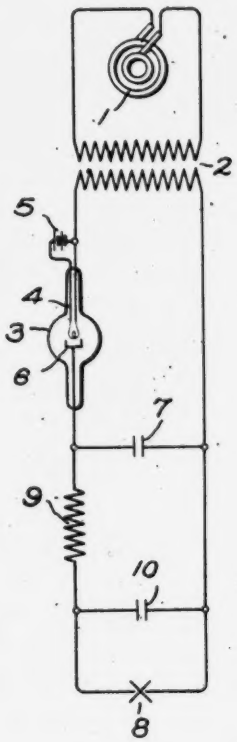


Fig. 2.

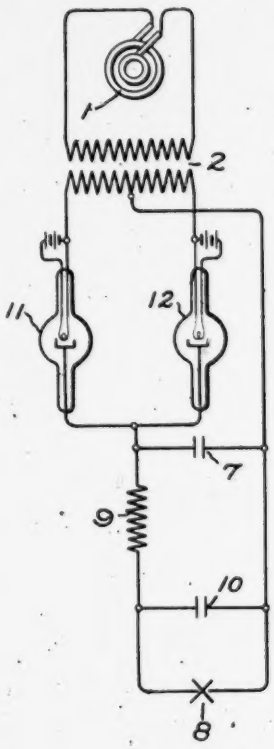
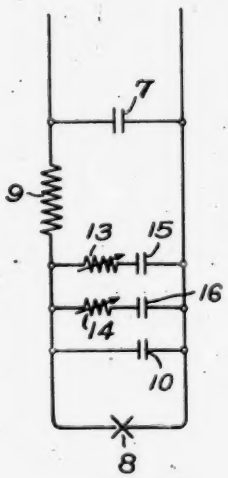


Fig. 3.



Inventor:
Albert W. Hull,
by Albert G. Davis
His Attorney.

UNITED STATES PATENT OFFICE. 777

ALBERT W. HULL, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

METHOD OF AND MEANS FOR OBTAINING CONSTANT DIRECT-CURRENT POTENTIALS.

1,251,377. Specification of Letters Patent. Patented Dec. 25, 1917.

Application filed December 22, 1915. Serial No. 68,289.

To all whom it may concern:

Be it known that I, ALBERT W. HULL, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Methods of and Means for Obtaining Constant Direct-Current Potentials, of which the following is a specification.

My present invention relates to means for obtaining unidirectional currents or potentials of constant value from variable sources, more particularly from a source of alternating current.

Various means have heretofore been employed for rectifying alternating currents and inductances and condensers have been utilized for reducing the variations in the rectified current. While the current which has been obtained in this way has been of sufficiently constant value for some purposes there are many cases in which the current variations are still great enough to be objectionable.

The object of my invention is to provide means for reducing these variations either in current or potential to such a degree that they will not be noticeable in any organization in which the current may be utilized. A more particular object of my invention is to provide a means for obtaining a high direct current potential of practically constant value.

The features of my invention which I consider novel are pointed out with particularity in the appended claims, the invention itself, however, with further objects and advantages will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 shows one embodiment of my invention and Figs. 2 and 3 show modifications thereof.

As indicated in Fig. 1 the alternating current which is to be rectified is derived from the alternator 1, which supplies the primary of the transformer 2, which is utilized to transform the current from the source 1 to such a degree that a direct current or potential of the desired value may be obtained by rectifying the current in the secondary of the transformer. The secondary circuit includes a rectifier 3 which is preferably of the incandescent cathode or kenotron type comprising a tungsten cathode 4 with battery 5 for heating to incandenscence, and the tungsten anode 6. By this means energy is conveyed unidirectionally to an energy storing device, which preferably consists of a condenser 7, which serves to store up that energy during the small fraction of a cycle during which it is receiving current and to supply the load 8 with energy during the remainder of the cycle. The energy thus stored up is fed to the load 8 through a high impedance 9 which is preferably an inductance but which in some cases may be an ohmic resistance or a device having ohmic resistance characteristics. This impedance together with the condenser 10 serves to smooth out the fluctuations in the voltage supplied by condenser 7. The action of the system herein shown may be described as follows:

The rectified voltage at the terminals of the condenser 7 is an irregular wave which may be analyzed into a constant potential plus a Fourier series of alternating potentials, of which the first component has a frequency equal to that of the source 1. The inductance 9 should have such a value that it will offer a very high impedance to these components as compared with the impedance of the condenser 10. Hence the amplitude which each component will have at the terminals of the condenser 10 and at the load terminals will be very small compared with the amplitude at the terminals of condenser 7, and this variation may be made as small as desired by increasing the values of inductance 9 and condenser 10. This will be true even when no power is being used. If the load 8 happens to be one of fairly low impedance it will assist the condenser 10 in reducing the value of the alternating current components. If on the other hand the load has a high impedance, such for example, as an incandescent cathode X-ray tube which has the characteristic that its current is practically independent of voltage it will have no steadying effect since its impedance is infinite for all frequencies. In this case the inductance 9 would be useless without the condenser 10. While the inductance 9 offers a high impedance to the alternating components of the current it offers a low impedance to the direct current component and hence comparatively large constant direct currents may be obtained.

From the above description it will be clear

that the efficiency of this arrangement depends upon making the impedance of 9 to the alternating components high in comparison with the impedance of condenser 10 and load 8 in parallel.

In Fig. 2 I have shown an arrangement which operates in the same manner as that shown in Fig. 1 with the exception that two rectifiers 11 and 12 are used in a well known manner in order to rectify both half waves of alternating current and thus feed energy into the condenser 7 during each half cycle instead of during every other half cycle.

In Fig. 3 I have shown another modification in which the impedance in parallel with the load is still further reduced by providing tuned circuits consisting of variable inductances 13 and 14 and condensers 15 and 16 in parallel with the load. One of these circuits is tuned to the frequency of the source which supplies the fluctuating current to condenser 7. The second circuit is tuned to the first harmonic of that frequency and, if desired, additional circuits may be provided tuned to higher harmonics. By this means the shunt impedance to the alternating components may be made very small in comparison with the impedance 9 and hence the fluctuations in the potentials supplied to the load may be made very small.

It will of course be understood that the variation in the rectified current will depend upon the capacity of the condensers 7 and 10, the value of inductance 9 and the frequency of the alternating current source and that by varying the proportions of these different factors substantially any degree of constancy in the rectified current may be secured. I have found in actual practice that with the arrangement shown in Fig. 2 with a 2000 cycle source of energy and with the condensers 7 and 10 having a capacity of about 1/1000 of a microfarad each, and the inductance 9 having a value of about 200 henries, it is possible to obtain five kilowatts of energy in the load circuit at any potential between 10,000 and 100,000 volts with a voltage fluctuation of less than 1%. The arrangement shown in Fig. 3 is especially suitable for use with lower frequencies than 2000 cycles as it is difficult to reduce the shunt impedance of the circuit sufficiently low for these lower frequencies by capacity alone without unduly increasing the size of the condenser 10.

While I have described the application of my invention to the obtaining of direct current of constant value from a source of alternating current it will be apparent that it will also be of utility in obtaining constant potential direct currents from other variable sources. For example, the condenser 7 which, in the embodiments which I have illustrated, constitutes a variable source of current, might be replaced by any other variable source with similar results. It will also be apparent that many modifications in the precise arrangement of the various devices used and in the specific form of the same may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. The method of obtaining a constant potential direct current from an alternating current which consists in rectifying the alternating current, storing up the energy in a capacity and delivering it continuously from the capacity to a utilization circuit having an impedance in shunt to a load through a series impedance which is high in comparison with the shunt impedance of the circuit.

2. The method of obtaining a constant potential direct current from an alternating current which consists in rectifying the alternating current, storing up the energy in a capacity and delivering it continuously to a utilization circuit having an impedance in shunt to a load through a series inductance which offers a high impedance to the alternating components of the current in comparison with the shunt impedance of the circuit.

3. The method of obtaining a constant potential direct current from an alternating current which consists in rectifying the alternating current, storing up the energy in a capacity, delivering it continuously to the utilization circuit through a high series impedance, and providing an impedance in shunt to the load which is low in comparison to the series impedance.

4. The method of obtaining a constant potential direct current from a variable voltage source which consists in continuously delivering current from said source to a utilization circuit having an impedance in shunt to a load through a series impedance which is high in comparison with the shunt impedance of the circuit.

5. The method of obtaining a constant potential direct current from a variable voltage source which consists in continuously delivering current from said source to a utilization circuit having an impedance in shunt to a load through a series inductance which offers a high impedance to the variable components of the current in comparison with the shunt impedance of the circuit.

6. The method of obtaining a constant potential direct current from a variable voltage source which consists in continuously delivering current from said source to a load circuit through a high series impedance and providing an impedance in shunt to the load which is low in comparison to the series impedance.

7. Means for obtaining a constant poten-

tial direct current comprising a source of alternating current, means for rectifying the alternating current from said source, an energy storing device for storing up the energy of the rectified current, and means for continuously supplying the stored up energy from said device to a load at a substantially constant rate comprising an inductance in series with said load and a condenser in shunt thereto, the impedance of said inductance being high in comparison to that of the condenser.

8. Means for supplying a load with a constant potential direct current comprising a source of alternating current, means for rectifying the current from said source, a condenser for storing up the energy of the rectified current, a device permanently connected in series with the load which offers a high impedance to the alternating component of the current flowing therethrough but a low impedance to the direct current component of said current and a device permanently connected in shunt to the load which offers a high impedance to the direct current component and a low impedance to the alternating current component.

9. Means for producing a constant high potential direct current comprising a source of alternating current of high potential, an incandescent cathode rectifier for rectifying the alternating current from said source, a condenser for storing up the energy of the rectified current, means for supplying the stored up energy to a load at a substantially constant rate comprising an inductance permanently connected in series with said load and a condenser permanently connected in shunt thereto, the impedance of said inductance being high in comparison to that of the condenser.

10. Means for supplying a load with a constant potential direct current from a variable voltage source comprising a device connected permanently in series with the load which offers a high impedance to the alternating component of the current flowing therethrough but a low impedance to the direct current component of said current, and a device connected permanently in shunt to the load which offers a high impedance to the direct current component and a low impedance to the alternating current component.

11. Means for supplying a load with a constant potential direct current from a variable voltage source comprising the combination of an inductance permanently connected in series with the load and a condenser permanently connected in shunt thereto, the impedance of said inductance being high in comparison with that of the condenser.

In witness whereof, I have hereunto set my hand this 21st day of December, 1915.

ALBERT W. HULL.

DEFENDANTS' EXHIBIT "D"

(Patent 1,195,632 to White)

W. C. WHITE.

CIRCUIT CONNECTION OF ELECTRON DISCHARGE APPARATUS.

APPLICATION FILED AUG. 23, 1915.

780 1,195,632. Patented Aug. 22, 1916.

Fig. 2.

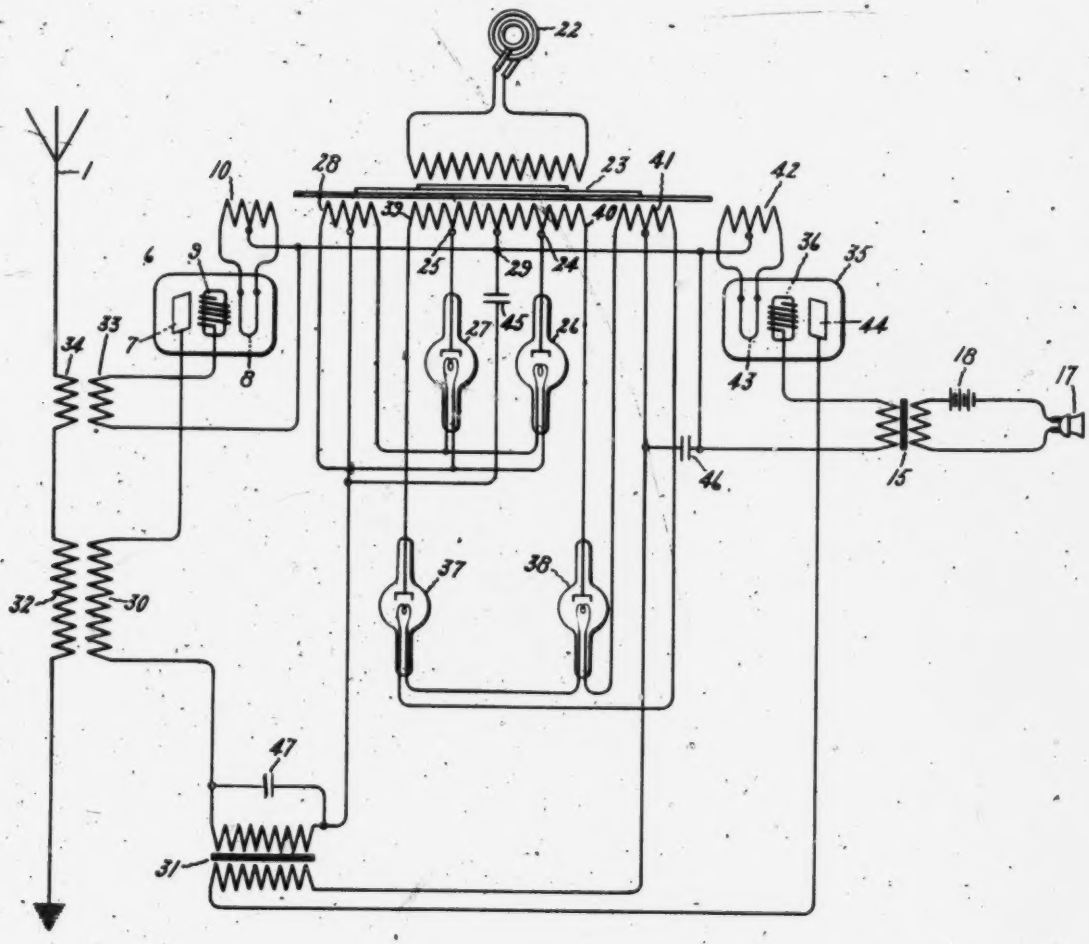
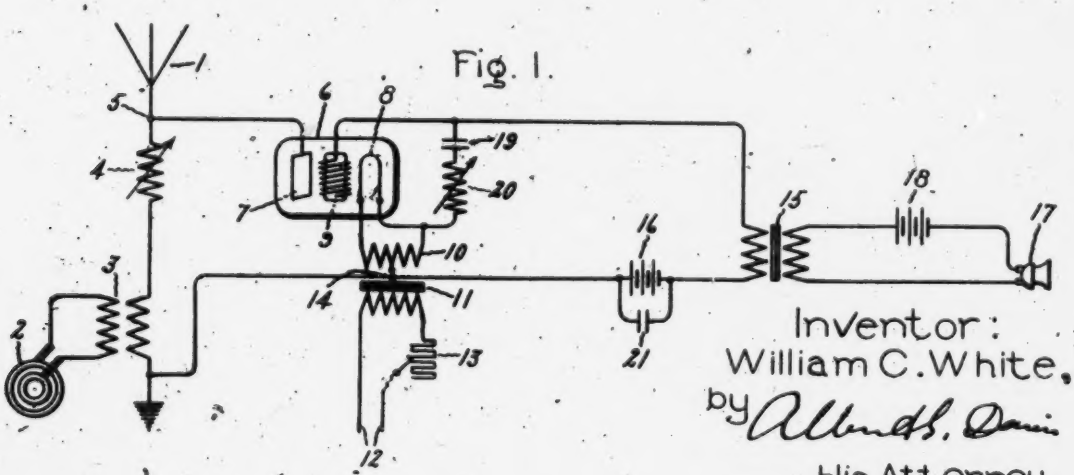


Fig. 1.



Inventor:
William C. White,
by Albert G. Davis
His Attorney.

UNITED STATES PATENT OFFICE.

WILLIAM C. WHITE, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

CIRCUIT CONNECTIONS OF ELECTRON-DISCHARGE APPARATUS.

1,195,632. Specification of Letters Patent. Patented Aug. 22, 1916.

Application filed August 23, 1915. Serial No. 46,770.

To all whom it may concern:

Be it known that I, WILLIAM C. WHITE, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Circuit Connections of Electron-Discharge Apparatus, of which the following is a specification.

This application is a continuation in part of my prior application, Serial No. 32,367, filed June 5, 1915.

My present invention relates to circuit connections for electron discharge apparatus and more especially electron discharge apparatus of the type in which a filamentary cathode inclosed in an evacuated envelop is provided with means for heating to incandescence to cause it to emit electrons which may serve to convey negative electricity to a coöperating anode inclosed in the same envelop. Such devices may be used for producing X-rays or rectifying alternating current or, when provided with a controlling grid, for amplifying variable currents, detecting wireless signals and for various other purposes.

It has been customary prior to my invention to provide for heating the cathode a direct current source such as a battery or direct current generator. The external circuit connections to the cathode have been made to one side of the filament and as a result all parts of the filament have not been at the same potential with respect to the anode or the grid, the difference between extreme ends being equal to the potential impressed upon the filament. Where a source of direct current is employed, this difference of potential is constant and, therefore, will not produce variations in the operation of the device. It is, however, more convenient in many cases to employ an alternating current for heating the filament, and, when this is done and the connections made to one side of the filament, the potential variations which are thereby introduced may seriously affect the efficient operation of the device.

The object of my invention is to provide an improved circuit connection for electron discharge devices whereby alternating current may be employed for heating the filament and the disadvantage above mentioned, as well as others which will hereinafter appear, may be overcome.

In the practical application of my invention, current for heating the filament is obtained from the secondary of a transformer and the connections from anode and grid to the cathode are made to the middle point of the secondary winding. When the connections are made in this way the average difference of potential at any instant between different portions of the cathode and the grid and anode, due to the heating current, will be zero.

My invention will best be understood by reference to the following description taken in connection with the accompanying drawing in which—

Figure 1 shows one organization for transmitting wireless signals in which the filament of the electron discharge device is supplied with alternating current and in which my invention may be employed to advantage; and Fig. 2 shows a different transmitting system in which a source of alternating current is utilized for other purposes as well as heating the cathodes of the various electron discharge devices used.

In the organization illustrated in Fig. 1, the antenna 1 is grounded as usual and has connected thereto a source of high frequency oscillations which in this case consists of a high frequency alternator 2. This may be inductively connected to the antenna by means of the transformer 3 or may be connected directly thereto, if desired. An inductance 4 which may be varied to tune the antenna circuit to the desired frequency may be placed in series with the antenna. An energy consuming device 6 which, in the present case, consists of an electron discharge relay comprising an exhausted envelop containing an anode 7, a cathode 8 and a conducting grid shaped body 9 interposed between the cathode and anode is connected to two points in the antenna circuit between which there is normally a large difference of potential. In the present case it is connected between the point 5 in the antenna and ground. The cathode 8 is of filamentary form, preferably of tungsten, and is provided with current for heating it to incandescence by the secondary 10 of the transformer 11 which may be supplied with alternating current from the mains 12. The temperature of the cathode may be adjusted by means of a variable resistance 13 in the primary circuit of the transformer. The

connection between the cathode of this device and ground is brought to the point 14 which is the middle point in the winding of the secondary 10. A second connection to this same point is made from the grid 9 through the secondary of the transformer 15 and battery 16. The primary circuit of the transformer 15 includes a telephone transmitter 17 with local battery 18. A second circuit consisting of the condenser 19 and the variable inductance 20 is provided between the grid 9 and cathode 8. In the operation of this system to secure the best possible results it will usually be found desirable to adjust the current flowing through relay 6 so that about one-half of the energy of the source 2 is normally diverted from the antenna circuit. This may be done by adjusting the potential impressed upon the grid 9 by the battery 16. In order that the currents produced in the secondary of the transformer 15 may not be compelled to flow through the battery 16, condenser 21 may be inserted in shunt to this battery. When sound waves act upon the transmitter 17 potential variations are set up in the secondary of the transformer 15 and the potential of the grid 9 is thereby varied in accordance with the variations in the sound waves. As a result the amount of energy which is diverted from the antenna through relay 6 is varied accordingly and there is a corresponding variation in the energy radiated from the antenna.

In the preferred construction of the electron discharge relay 6, the anode 7 is made up of one or more plates of considerable area and the grid 9 consists of a number of turns of fine wire wound on a supporting frame work and located in parallel relation to the anode plate or plates. The cathode 8 is also preferably located in a plane parallel to the grid and anode. The distance between these members is preferably small and as a result there is an appreciable capacity between them. It will be seen that with the arrangement indicated the anode 7 is alternately positive and negative with respect to the cathode and that as a result the grid 9 will have induced thereon by electrostatic induction positive and negative charges. Although the grid and cathode are connected electrically reversals in polarity in the induced charges are so rapid that the potential difference between the two at times may become very large, the secondary of the transformer 15 offering high impedance to the flow of high frequency charging current between the grid and cathode. As a result the positive potential which may be induced on the grid 9 when the anode is also positive may become so great as to allow enough current to flow through the relay 6 to divert from the antenna nearly all of the energy from the high frequency source, even when no potential is induced upon the grid by means of the telephone transmitter. Also the potentials induced by the secondary of the transformer 15 are in most cases small in comparison to this induced potential and hence will produce little variation in the current flowing through the relay 6. In order to overcome this difficulty the circuit comprising the condenser 19 and inductance 20 is tuned to the frequency of the source 2 so as to serve as a short circuit between grid and cathode for these induced charges.

In case the connection from the grid to the cathode through the secondary of transformer 15 were made to one end of the secondary 10 which supplies current for heating the filament the difference of potential between the opposite end of the cathode and the grid would fluctuate by an amount equal to the filament voltage. As a result there would be a corresponding variation in the amount of energy diverted from the antenna. That is, in addition to the variations produced by the action of the sound waves there would be variations having a frequency equal to that of the source supplied to transformer 11. These variations of course would impair the transmission of the desired signals. This difficulty however is overcome by connecting the grid to the middle point of transformer 10 thereby neutralizing the effect of any differences of potential between grid and filament due to the potential alternations of the source used for heating the filament. The amount of energy diverted from the antenna also depends upon the difference of potential between the anode and cathode and with the connection from anode to cathode. Made to one side of the filament there would be the same variation in potential between anode and cathode as between cathode and grid. This difficulty is also overcome by connecting the anode to the middle point of secondary 10.

In the system illustrated in Fig. 2, electron discharge device 6 is employed to produce continuous waves in the antenna 1. In order to accomplish this, anode 7 and cathode 8 are connected to a source of direct current which is obtained by rectifying alternating current from the source 22 which supplies transformer 23, the secondary turns of which are subdivided to give different voltages. One group 10 of the secondary turns provides current for heating cathode 8. Current for the plate circuit of device 6 is derived from the secondary turns between points 24 and 25, electron discharge rectifiers 26 and 27 being employed to rectify the alternating current. The group of secondary turns 28 provides current for heating the cathodes of these rectifiers. Connection to cathode 8 is made between a neutral point 29 in the transformer secondary and the middle point of group 10 of secondary turns.

A connection is also provided from the anode 7 to the cathodes of rectifiers 26 and 27 through inductance 30 and the secondary of transformer 31 to the middle point of group 28. The inductance 30 is inductively related to the inductance 32 in the antenna. The circuit, which includes the cathode 8 and the grid 9, contains an inductance 33 which is coupled to a second inductance 34 in the antenna. The coupling between 30 and 32 is preferably close, while that between 33 and 34 may in some cases be made very loose. The circuit which comprises the direct current source of supply, the inductance 30, the cathode 8 and anode 7, for convenience of description I designate the plate circuit. The circuit which comprises the grid 9, inductance 33 and cathode 8, I designate the grid circuit. With this arrangement, when current starts to flow in the plate circuit, potential is induced in coil 32 and in the antenna. This produces a corresponding induced potential in coil 33 and varies the potential of the grid 9. This change in grid potential in turn produces a variation in the current in the plate circuit. When the potential produced in the grid circuit causes the grid to become more negative the current flowing in plate circuit is decreased while an induced potential which makes the grid more positive increases the current flow in the plate circuit. These variations in the current in the plate circuit produce an alternating current in the antenna, the frequency of which will be the same as the frequency to which the antenna is tuned. The amplitude of the high frequency waves thus produced in the antenna will, among other things, depend upon the potential of the direct current source and will be constant as long as this potential is constant and other conditions also remain unchanged but their amplitude will vary in accordance with any variations in potential supplied to the plate circuit. In order to vary the amplitude of these waves in accordance with sound waves, potential variations corresponding to those set up in the secondary of transformer 15 are impressed upon the plate circuit. The potential variations in the secondary of transformer 15 are in the present case amplified by a second electron discharge device 35 similar in structure to device 6. This is done by impressing the potential variations upon the grid 36 of device 35. The amplified potential variations thereby set up in the plate circuit of device 35 are impressed upon the plate circuit of device 6 by means of the transformer 31. A direct potential for the plate circuit of device 35 is obtained in the same manner as for device 6. In the operation of this particular system, I have found it desirable to employ a higher voltage for device 35 than for device 6. To provide this higher voltage, a larger number of secondary turns of the transformer are utilized and rectifiers 37 and 38 are connected to points 39 and 40 respectively. The group of secondary turns 41 provides current for heating the cathodes of these rectifiers. Connection is made from point 29 to the middle point of group 42, which provides current for heating cathode 43 and from the anode 44 of device 35 to the cathodes of rectifiers 37 and 38 through the primary of transformer 31 to the middle point of group 41. Condensers 45 and 46 may be employed to smooth out the variations in potential of the rectified current supplied to devices 6 and 35 and condenser 47 to provide a shunt path for the high frequency component of the current in the plate circuit of device 6 around the secondary of transformer 31. When high frequency variations of current are occurring in the plate or grid circuits of the different devices, this current passes through the central taps of the transformers to the filaments without undue impedance, and divides equally between the two legs of the filament loop, as the inductance of the two sides of the winding is neutralized.

While I have described the application of my invention to only two systems for transmitting wireless signals, it will be apparent to one skilled in the art that it will be of utility in many other organizations in which electron discharge devices are employed, for wireless signaling or other purposes, and that numerous applications thereof may be made without departing from the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. The combination with an electron discharge device comprising an evacuated envelop having therein a filamentary cathode and a coöperating anode of a source of alternating potential applied to said cathode for heating it to incandescence and external circuit connections between said cathode and anode so arranged that the average potential difference between cathode and anode at any instant is independent of the potential applied to the cathode for heating purposes.

2. The combination with an electron discharge device comprising an evacuated envelop having therein a filamentary cathode and a coöperating anode of a transformer connected to a source of alternating current and having its secondary connected to said cathode for heating it to incandescence and an external circuit connection between said anode and the central point in the secondary winding of said transformer.

3. The combination with an electron discharge device comprising an evacuated envelop having therein a filamentary cathode, a coöperating anode, and a discharge controlling grid, of a source of alternating po-

tential applied to said cathode for heating it to incandescence and external circuit connections between said cathode and anode and between said cathode and grid so arranged that the average potential difference between cathode and anode and between cathode and grid at any instant is independent of the potential applied to the cathode for heating purposes.

4. The combination with an electron discharge device comprising an evacuated envelop having therein a filamentary cathode, a coöperating anode and a discharge controlling grid of a transformer connected to a source of alternating current and having its secondary connected to said cathode for heating it to incandescence and external circuit connections between said anode and said grid, and the central point in the secondary winding of said transformer.

5. The combination with an electron discharge device comprising an evacuated envelop having therein a filamentary cathode and a discharge controlling grid of a source of alternating potential applied to said cathode for heating it to incandescence and external circuit connections between said cathode and grid so arranged that the average potential difference between cathode and grid at any instant is independent of the potential applied to the cathode for heating purposes.

6. The combination with an electron discharge device comprising an evacuated envelop having therein a filamentary cathode and a discharge controlling grid of a transformer connected to a source of alternating current and having its secondary connected to said cathode for heating it to incandescence and an external circuit connection from said grid to the central point in the secondary winding of said transformer.

In witness whereof, I have hereunto set my hand this 20th day of August, 1915.

WILLIAM C. WHITE.

DEFENDANTS' EXHIBIT "E"

(Patent 1,587, 084 to Robinson)

785 June 1, 1926. 1,587,084

G. D. ROBINSON

CIRCUITS FOR ELECTRON DISCHARGE DEVICES

Filed Nov. 1, 1920 2 Sheets-Sheet 1

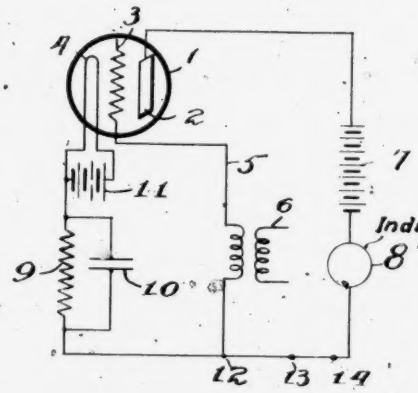


Fig. 1.

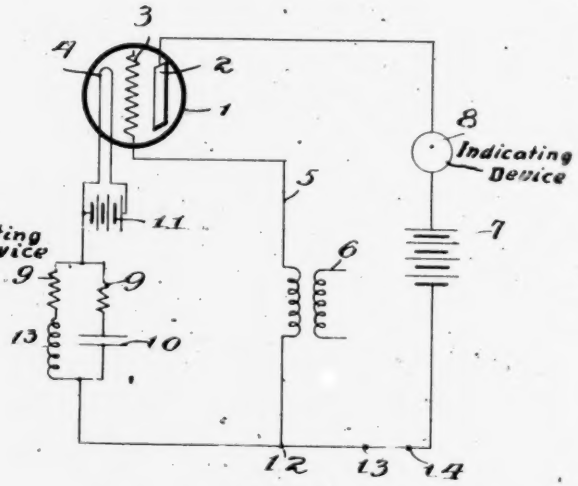


Fig. 2.

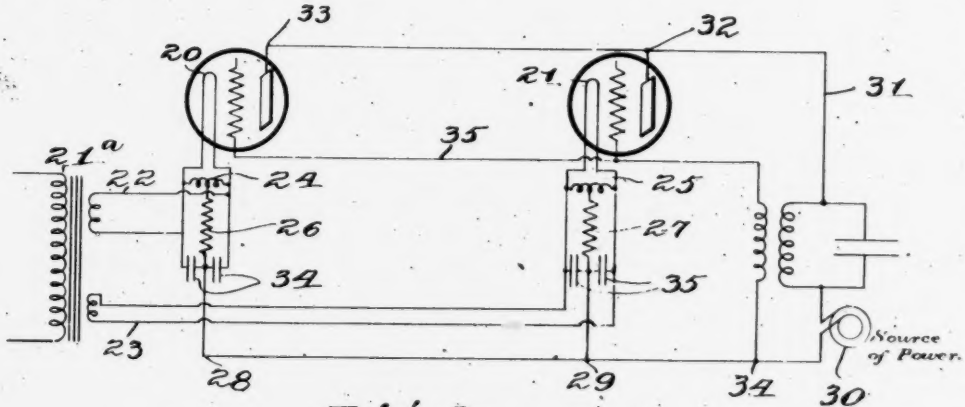


Fig. 3.

Inventor
G. D. Robinson.

By Shuttleworth & Ingerson
Attorneys

786 June 1, 1926. 1,587,084

G. D. ROBINSON

CIRCUITS FOR ELECTRON DISCHARGE DEVICES

Filed Nov. 1, 1920 2 Sheets-Sheet 2

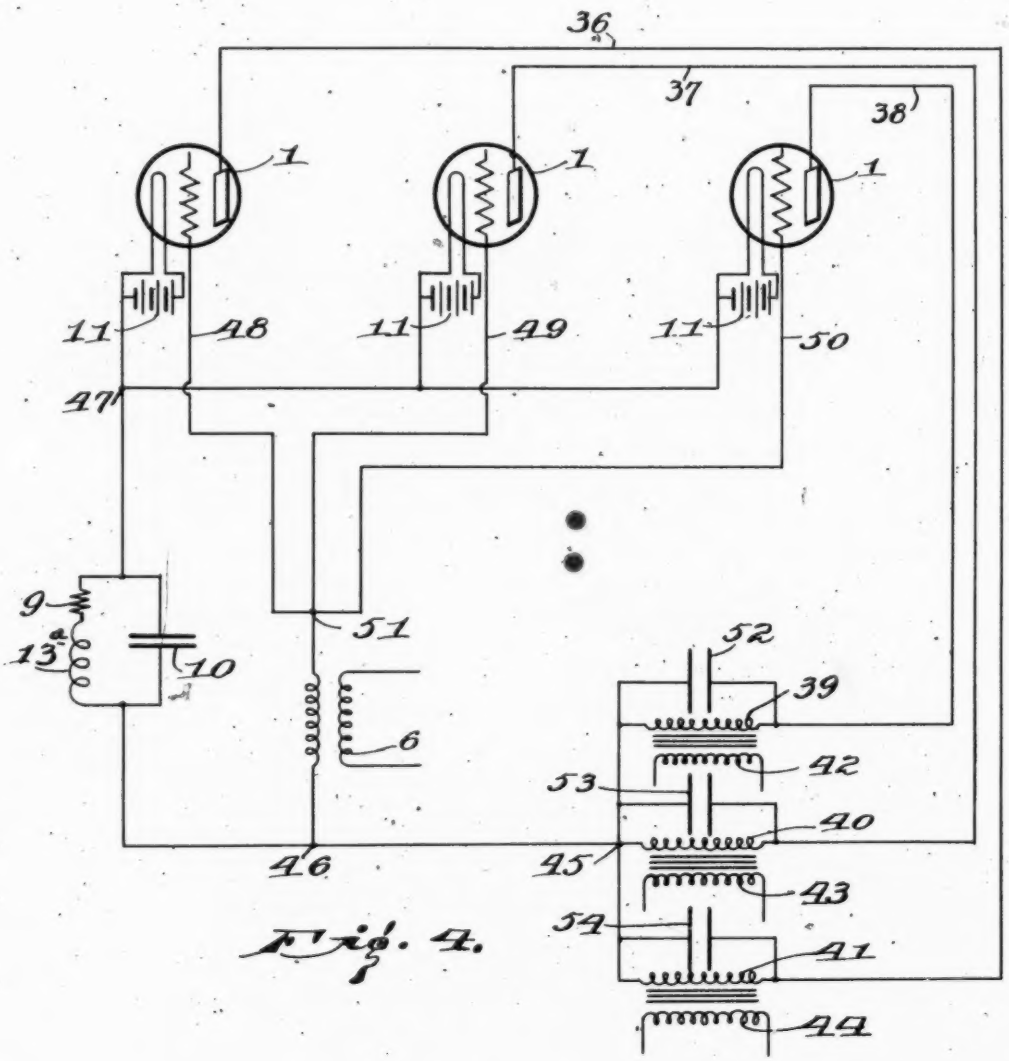


Fig. 4.

Inventor
G. D. Robinson.

By Stuttevant Mussoin
Attorneys

UNITED STATES PATENT OFFICE.

GORDON DUDLEY ROBINSON, OF ANNAPOLIS, MARYLAND.

CIRCUITS FOR ELECTRON DISCHARGE DEVICES.

Application filed November 1, 1920. Serial No. 421,027.

The present invention relates to methods and means for controlling potentials and current flowing in circuits associated with the electron discharge devices. In one form the invention consists in an arrangement of circuits in connection with an electron discharge device in which the value of a varying current is regulated by means of a regulating current or potential which in itself has a varying regulating action on the controlled current depending upon the frequency and decrement of the controlled current or potential.

The present invention contemplates the utilization of an arrangement of circuits associated with electron discharge devices in which a modifying or regulating effect of a regulating current or potential is utilized to prevent variations of the control current or potential at certain definite frequencies while regulating to a lesser extent changes in the controlled current or potential at other frequencies. The modifying or regulating effect of the regulating current or potential may also be utilized to prevent variations of the control current or potential except at certain predetermined frequencies.

It is an object of the present invention to provide an arrangement of circuits associated with an electron discharge device whereby a regulating potential is superimposed upon the actuating grid potential.

It is a further object of the present invention to provide an arrangement of circuits associated with electron discharge devices whereby a regulating potential is superimposed upon the actuating grid potential, the regulating potential having a variable value in accordance with the frequency and decrement of the current flowing in one of the associated circuits.

It is a still further object to provide an arrangement of circuits associated with electron devices in which the plate circuits are energized from an alternating current supply, and a regulating potential is superimposed upon the grid potential for the purpose of minimizing the low frequency variations in plate current.

The present invention contemplates the use of any form of electron discharge device having one or more anodes, one or more cathodes and one or more control members such as a grid, the electron discharge device preferably being of the type in which the slope of the internal characteristic is steep so that relatively large changes of plate current are produced by small changes of grid potential.

In the accompanying drawings:

Figure 1 shows diagrammatically an arrangement of circuits representing a preferred form of my invention;

Figure 2 a modification thereof; and

Figure 3 a second modification in which the average current in each of a plurality of parallel connected tubes is regulated in order to maintain the same approximately constant in spite of variations of potential existing in the grid circuits of the tubes.

Figure 4 shows a third modification in which a plurality of parallel connected tubes have their plate circuits energized from a polyphase alternating current source, a regulating potential being impressed upon the grid circuits to minimize the low frequency variations in the average of all the plate currents.

Referring to Figure 1, an electron discharge device or audion 1, is shown, having a plate 2, grid 3, and filament 4. Connected to the grid 3 is a controlling circuit 5 adapted for connection to any source of actuating potential in any well known manner such as by the coupling 6, this source being of a magnitude suitable for the operation of the tube or audion. The plate or anode 2 is connected through a battery or suitable source of potential 7 through a useful load 8, which may include a current indicating device, to the filament through an aperiodic impedance consisting (as shown in Figure 1) of a resistance 9 in parallel with a condenser 10. Such an impedance is differently responsive to different frequencies yet substantially constant over a certain useful range of frequencies. Filament battery 11 supplies energy for the heating of the filament 4.

Assuming that a current is flowing from the plate 2 to the filament 4 through the tube, if by means of the grid circuit 5 a difference of potential is established between the grid and filament making the grid more positive than before, a much larger current will flow from the filament 4 to the plate 2 through the external circuit. This increased current flow will in turn cause an increased drop of potential through the resistance 9 and a corresponding change in the value of the charge in the condenser 10. After the charge in the condenser 10 has passed the

transitory state and becomes constant, the drop of potential through the resistance 9, being in the grid filament circuit, will act in opposition to the actuating potential previously impressed upon the circuit 5 so that the change in the anode or plate current is substantially less than would have been the case if the grid circuit 5 were not connected to the external plate circuit at 12 so as to be susceptible to the drop of potential through the impedance composed of resistance 9 and condenser 10. It will therefore be seen that variations in the plate current flowing in the external circuit superimposes upon the grid a regulating potential opposite in sign to that of the actuating potential imposed upon the grid from the source 6. If, as in normal operation, a high frequency actuating potential is imposed upon the grid circuit from the source 6, corresponding variations in the anode or plate current will be produced, the same flowing through the external circuit. These variations of plate current will pass through the condenser 10 readily, only the average or direct component of the plate current being compelled to pass through the resistance 9. As a result of this, variations of plate current will be but little modified by the drop of potential through the impedance consisting of resistance 9, capacity 10, and such stray or distributed capacity as is inherent in the apparatus, while at the same time any gradual changes in the average value of plate current will introduce a corresponding potential drop through the resistance 9, and impress upon the grid circuit a regulating potential which will tend to prevent this change. This arrangement of circuits thereby tends to keep an average constant plate current with but little effect upon any high frequency current flowing in the plate circuit. The circuit just described is of course adapted for reception, as well as the production of high frequency oscillations.

The modification shown in Figure 2 consists of the same circuit arrangement as that described in connection with Figure 1 with the exception that a slightly different form of impedance is disclosed. The impedance in this case consists of resistance or resistances 9 and inductance 13 in parallel with the condenser 10. By such construction this impedance may be made resonant to certain definite frequencies and the regulating potential impressed upon the grid circuit will have a maximum value with respect to the plate current flowing at certain desired frequencies. The impedance may be designed to have either a maximum or a minimum value for any given range of frequencies. The effectiveness of an impedance used in this circuit arrangement for regulating the anode or plate current does not depend upon its absolute value but rather upon its value compared to the internal impedance of the tube. While not limiting myself to any specific values of impedance 9 and 10, to be used by way of example it is stated that very satisfactory results were obtained where the resistance 9 was composed of slightly inductive resistance unit having an impedance of 1000 ohms, the condenser 10 having also an impedance value of about 1000 ohms and the internal impedance of the plate circuit was in the order of 100,000 ohms. The loop thus formed is aperiodic, i. e., its ratio of resistance to inductance and capacity inhibits oscillations. Since the resistive impedance is substantially independent of frequency and the inductive impedance is small, the capacitive impedance determines its action upon currents of different frequencies.

In some instances it has been desirable to control the plate current by the insertion of an impedance between points 13 and 14 in the plate circuit as shown in Figures 1 and 2. Such regulation demands the use of an impedance which tends to cut down the average value of plate current. By making use of circuits such as disclosed in Figures 1 and 2, however, the use of a much smaller impedance located as shown secures the desired regulation. The relationship existent between the values of the impedance shown in these figures and the fictitious impedance located between points 13 and 14 in the plate circuit which it replaces is substantially $(\mu+1)Z$, in which Z is the actual value of the impedance used and μ is the amplification constant of the tube when the grid is operated with but a negligible direct component in the grid current.

Figure 3 discloses a modification in which regulating potentials are impressed upon the grid circuits of a plurality of tubes in parallel for the purpose of obtaining a definite division of load between the tubes and at the same time appreciably preventing variation in the average value of plate current. In this circuit arrangement, the filaments 20 and 21 are heated by means of alternating current, although this is of course not a necessary requirement for the application of the present invention, the heating current being obtained from a transformer 21^a having separate secondaries 22 and 23 for the tubes. Choke coils 24 and 25 are connected across the terminals of the filaments 20 and 21 and have central taps leading therefrom through resistances 26 and 27 respectively to the plate circuit 28, 29, 30, 31, 32 and 33. Condensers 34 and 35 cooperate respectively with the impedances 26 and 27 in substantially the same manner as resistance 9 and capacity 10 in Figure 1 to impose upon the grid circuit 34 and 35 regulating potentials in accordance with the voltage drop existent in the external circuits between filaments 20

and 21 and the point 34 in the plate circuit. In each of the tubes there is therefore a tendency to hold an average definite value of anode current and there is thus a tendency towards a definite division of load between the tubes. It is further obvious that this arrangement may be applied to any number of tubes in parallel.

The modification shown in Figure 4 discloses the present invention as applied to a plurality of tubes in parallel in which the plate circuits are energized from an alternating current source. In this figure the tubes 1 have their filaments excited in any suitable manner as by batteries 11, the anodes of the tubes being connected respectively by means of circuits 36, 37 and 38 to the secondaries 39, 40 and 41 of low frequency transformers. The primaries of these transformers 42, 43, and 44 are connected to a three phase alternating current source. Instead of using separate transformers a three phase transformer of any suitable type might be employed. It is also feasible to employ either two phase or single phase current to provide for the excitation of the plate circuit, the single phase current being applied either directly to the primaries of the three transformers, or being connected thereto thru any well-known type of a phase splitting device so that the phases in the secondaries of the transformers will be suitably displaced one from the other.

The other ends of the secondary windings are connected to a common conductor at the point 45, a circuit leading from this point thru the regulating impedance 9, 10, 13ª to a common point 47 to which point the circuit branches to the three filaments of the tubes. The grid circuits 48, 49 and 50 lead to a common point 51 which is connected to the common plate circuit at 46, a suitable source of controlling or actuating potential being introduced in the common grid circuit by the coupling 6. As here shown the coupling 6 is adapted to energize the common portion of the grid circuits, but the actuating potential might also be impressed separately upon the separate grid circuits at points between the common point of connection 51 and the grids. Condensers 52, 53, and 54 are placed in parallel with the secondaries of the low frequency transformers in the plate or anode circuits in order to permit the high frequency pulsations to flow in the anode circuits without interference. From the description of the circuits already given in connection with Figure 1, it will be evident that the impedance 9, 10, 13ª imposes upon the grid circuits of the tubes, a regulating potential the tendency of which is to prevent variations in the plate current. In the arrangement of the circuits shown in connection with Figure 4 the resultant variation of the plate current is primarily much reduced when three phase current is utilized for the excitation of the plate circuits, the overlapping of the phases producing a resultant effect which is that of a varying direct current. By utilizing applicant's method of applying a regulating potential to the grid circuits the varying flow of current in the plate circuits is still further minimized, and a tendency towards a smooth resultant of the plate current is obtained.

The particular embodiments of my invention herein disclosed are of course susceptible to considerable variation without departing from the spirit thereof, and it is to be understood that many changes might be made by those skilled in the art within the scope of the invention as defined within the appended claims.

What I claim is:

1. The combination with an electron discharge device having a cathode, an anode, and a grid, of an external circuit connecting the cathode and grid and having therein means to impress upon said grid an actuating potential from an external source, a second external circuit connecting said cathode and anode and including an indicating device and having a portion in common with said first circuit, and an aperiodic loop circuit in series with the common portion of said circuits whereby low frequency variations in the anode current are opposed.

2. The combination with an electron discharge device having a cathode, an anode, and a grid, of an external circuit connecting the cathode and grid and having therein means to impress upon said grid an actuating potential from an external source, a second external circuit connecting said cathode and anode and including an indicating device and having a portion in common with said first circuit, and an aperiodic loop circuit comprising two branches in series with the common portion of said circuits, one of said branches containing inductive reactance and ohmic resistance and the other branch containing capacitive reactance, whereby said loop circuit is more actively operative at a certain frequency or frequencies than at other frequencies whereby low frequency variations in the anode current are opposed.

3. The combination with an electron discharge device having a cathode, an anode and a grid, of an external circuit connecting the cathode and grid and having intercalated means to impress upon said grid an actuating potential, a second external circuit connecting said cathode and anode and having a portion in common with said first external circuit, and an aperiodic loop in series in the common portion of said circuits to oppose variation of the anode current.

4. The combination with an electron dis-

charge device having at cathode, an anode and a grid, of an external circuit connecting the cathode and the grid and having intercalated therein means for impressing an actuating potential upon said grid, a second external circuit connecting said cathode and anode, said external circuits having a common portion, and means in said common portion whose impedance varies inversely with the frequency to oppose low frequency variations in the anode current or potential.

5. The combination with an electron discharge device having a cathode, an anode and a grid, of an external circuit connecting the cathode and the grid and having intercalated therein means for impressing an actuating potential upon said grid, a second external circuit connecting said cathode and anode, said external circuits having a common portion, and means controlled by the anode current in said common portion whose impedance varies inversely with the frequency to oppose low frequency variation in the anode current.

6. The combination with an electron discharge device having a cathode, an anode and a grid, of an external circuit connecting the cathode and grid and having intercalated therein means for impressing upon said grid an actuating potential from an external source, a second external circuit connecting said cathode and anode, a common portion of said circuits having two branches constituting a series loop circuit, and a resistance and a capacitance respectively in said branches, said loop circuit serving to oppose variations in the anode current or potential.

7. The combination with a circuit embodying a plurality of electron discharge devices in parallel, each having a cathode, an anode, and a grid, of grid circuits connecting each grid to the corresponding cathode, anode circuits connecting each anode to the corresponding cathode, said anode circuits having a common conductor, a source of anode current in said conductor, a portion of each anode circuit being common to the grid circuit of the corresponding electron discharge device, and means in said common portion for opposing changes in the anode current of that particular device.

8. The combination with a circuit embodying a plurality of electron discharge devices in parallel, each having a cathode, an anode, and a grid, of grid circuits connecting each grid with the corresponding cathode, anode circuits connecting each anode with the corresponding cathode, said anode circuits having a common conductor, a source of anode current in said common conductor, a portion of each anode circuit being common to the grid circuit of the corresponding electron discharge device, and means in said common portion for opposing changes in the anode current of that particular device, said means being more actively operative at a certain frequency or frequencies than at other frequencies.

9. The combination with an electron discharge device having a cathode, an anode, and a grid, of an external circuit including a source of electricity to energize said cathode and connected thereto, an inductance connected in shunt across said cathode, two condensers in series connected in shunt across said cathode, a resistance connected between the midpoint of said inductance and the midpoint of said condensers, an external conductor connecting the grid with the midpoint of said condensers, and a second external conductor connecting the anode with the midpoint of said condensers.

10. The combination with a circuit employing a plurality of electron discharge devices in parallel, each having a cathode, an anode, and a grid, of an anode circuit connected to all of said anodes, a source of anode current in said anode circuit, and means for a substantially equal distribution of load between said devices comprising an impedance of relatively high value for a constant or slowly varying current inserted in the anode circuit of each device at a point common to the grid circuit of said device so that the voltage drop due to the anode current flowing through said impedance will be impressed upon the grid circuit of that tube.

11. In a circuit including a vacuum tube comprising a cathode, a grid and an anode, connections for energizing the said elements, a portion of said connections being common, means in said common portion for opposing oscillations due to electrical interaction comprising a loop circuit containing resistance and capacity, the reactance of the former being greatly in excess of that of the latter at operating frequencies.

In testimony whereof, I affix my signature.

GORDON DUDLEY ROBINSON.

DEFENDANTS' EXHIBIT "F"

(Patent 1,105,924 to Pridham & Jensen)

E. S. PRIDHAM & P. L. JENSEN.

TELEPHONE.

APPLICATION FILED AUG. 20, 1913.

1,105,924.

Patented Aug. 4, 1914.

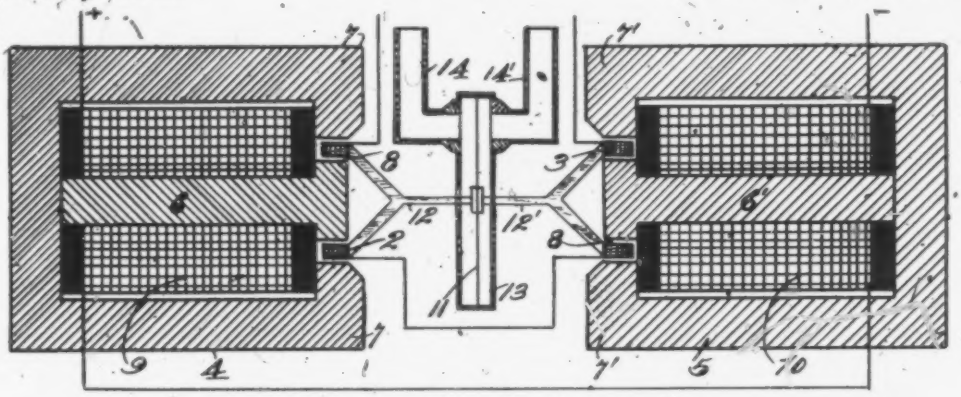


Fig. 1.

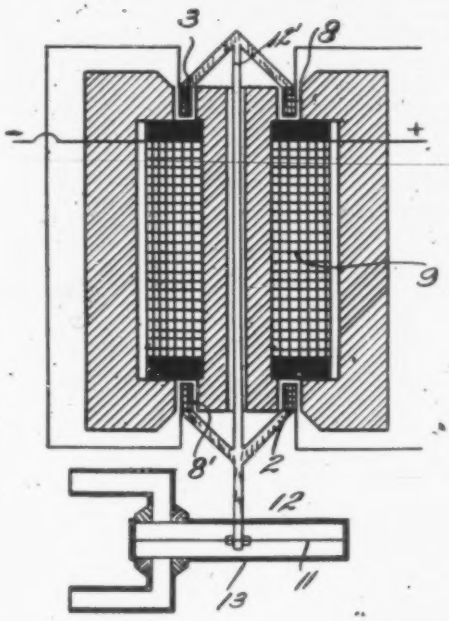


Fig. 2.

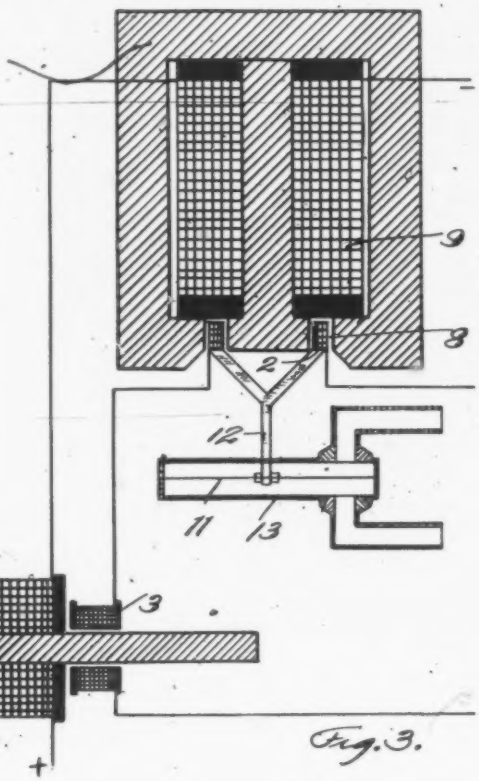


Fig. 3.

WITNESSES:

F. E. Maynard

Charles Pickles

INVENTORS

Edwin S. Pridham

Peter L. Jensen,

BY F. H. Strong

ATTORNEY

UNITED STATES PATENT OFFICE. 792

EDWIN S. PRIDHAM AND PETER L. JENSEN, OF NAPA, CALIFORNIA, ASSIGNORS TO COMMERCIAL WIRELESS & DEVELOPMENT COMPANY, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF ARIZONA.

TELEPHONE.

1,105,924. Specification of Letters Patent. Patented Aug. 4, 1914.

Application filed August 20, 1913. Serial No. 785,694.

To all whom it may concern:

Be it known that we, EDWIN S. PRIDHAM, a citizen of the United States, and PETER L. JENSEN, a subject of the King of Denmark, residing at Napa, in the county of Napa and State of California, have invented new and useful Improvements in Telephones, of which the following is a specification.

This invention relates to telephones, and particularly to receiving apparatus.

The object of the present invention is to provide a telephonic receiving instrument of the moving annular coil type, so constructed that fluctuations of field strength acting upon the telephonic conductor will have no effect upon the diaphragm of the device.

Types of receiving instruments employing magnetic fields in which are disposed freely movable coils are known and have been used with a high degree of success.

In our invention we employ a combination of magnetic structures with central poles and circumferential surrounding poles; between the central poles and surrounding poles are air-gaps of substantially annular form. In these air-gaps are respectively disposed portions of a telephonic conductor. These portions of conductor take the form of annular coils which are freely movable in the air-gaps of the magnetic circuits. Either one or both of the coils may be connected to the diaphragm of the instrument. When both coils are connected to the diaphragm the electrical connections must be such that the effects are additive upon the diaphragm. In any case the sections of the telephonic conductor are connected together so that telephonic currents may act throughout the entire length of the conductor.

In instruments of the class wherein an annular movable coil has been employed it has heretofore been necessary to use direct current from either a primary or secondary battery when electro-magnets produce the magnetic field. When direct current from a dynamo has been used a strong reaction takes place owing to fluctuations of the current due to the commutator action. This reaction is caused by variations of the field strength which induces currents in the telephonic coil. These currents reacting upon the normal field strength produce the vibration which greatly interferes with the action of the instrument. Concerning the development of these induced currents in the telephonic coil, it can be shown that a decreasing field strength will produce an induced current in the same direction as the energizing current while an increasing field strength produces an induced current in the opposite direction to the energizing current.

In the instrument under consideration we have used direct current with a high degree of success even when the fluctuations of current were strong. The desired results in this instrument being obtained by dividing the telephonic conductor in two sections, each section being subjected to the influence of a magnetic field energized by the fluctuating current. The sections of the telephonic conductor are then so connected together that the induced currents generated in either section neutralize each other while the telephonic current from the working source is free to flow throughout the entire conductor and accomplish its purpose.

As will be seen from the drawings, both sections of the conductor may be made to act upon the diaphragm or only one section used for that purpose, the other section being used to neutralize the induced currents in the acting section.

Our invention simply comprehends the use of a divided telephonic conductor each section of which is subjected to a magnetic field energized from a source of fluctuating direct current the sections being so connected together that the induced currents can have no effect in actuating the diaphragm of the instrument. It is of course necessary so to design the instrument that the value of the induced currents in either section are equal.

The invention consists of the parts and the construction and combination of parts as hereinafter more fully described and claimed, having reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic view of the instrument in cross section. Fig. 2 is a diagrammatic view in cross section of a variation. Fig. 3 shows in diagrammatic view a further variation in the application of the principle.

Referring to Fig. 1, we have shown the telephonic conductor wound in two sections 2 and 3, each of said sections consisting of substantially annular coils of many turns of insulated wire. Each of the annular coils is disposed to be freely movable in the respective air-gaps of the magnets 4 and 5. These magnets consist respectively of the central poles 6 and 6′, substantially surrounded by the poles 7 and 7′; the center poles being separated from the outer poles by the substantially annular air-gaps 8 and 8′.

The magnets are energized by current flowing through the magnet coils 9 and 10. These magnet coils are properly connected together and energized from the same source of current.

The magnets 4 and 5 with their respective telephonic coils 2 and 3 are disposed on opposite sides of the diaphragm 11 to which the telephonic coils are rigidly connected by the arms 12 and 12′. The diaphragm 11 is contained in the sound-box 13 from which listening tubes 14 and 14′ extend, one from either side of the diaphragm 11.

The telephonic coils 2 and 3 are so connected together electrically that when telephonic current passes through them, and the magnets 4 and 5 are energized, the effect upon the diaphragm 11 will be additive. Now, if the coils 2 and 3 are properly connected together to produce an additive effect upon the diaphragm, it can be shown that induced currents formed in the coils 2 and 3 by any variation of the lines of force in the air-gaps 8 and 8′, due to fluctuations of the energizing current, will be neutralized by their mutual action, as hereinbefore described.

Referring to Fig. 2, we show a form of the instrument in which only one energizing coil 9 is used to produce the magnetic fields in the air-gaps 8 and 8′. The telephonic coils 2 and 3 are disposed respectively in the air-gaps 8 and 8′ and are connected to the diaphragm 11 by the rigid arms 12 and 12′. In this form of the invention one of the coils is connected to the diaphragm 11 by the arm 12′ which extends through the central pole piece 6. The coils 2 and 3 are connected together electrically to produce an additive effect upon the diaphragm when telephonic current passes through them. When so connected together it will be found that any fluctuation of the lines of force in the air-gaps 8 and 8′ will produce induced currents in the coils 2 and 3, which will neutralize each other.

Referring to Fig. 3, we have shown the telephonic conductor in two sections 2 and 3, each of which is subjected to the effect of magnetic fields energized by the same current. The coil 2 consists of a substantially annular coil disposed to be freely movable in the air-gap 8 and is connected by the rigid arm 12 to the diaphragm 11. Coil 3 of the telephonic conductor is subjected to the influence of the magnetic field produced by the energizing coil 10. The lines of force in the air-gap 8 are produced by the energizing coil 9. Current from the same source is used to energize both coils 9 and 10.

The inductive relation between the coil 3 and the magnetic field produced by coil 10 is variable by movement of the coil 3 in relation with the magnetic coil 10. Since the two energizing coils are fed by the same source of current, the magnetic fields produced by them will be subjected to the same variations.

The telephonic coil 2 is connected electrically to coil 3 so that induced currents formed by any variation of the field strength of their respective magnetic fields will neutralize each other. The strength of the induced current in coil 3 may be varied to exactly balance the induced current formed in the coil 2, by changing the inductive relation of coil 3 with respect to the magnetic field produced by the energizing coil 10.

Having described our invention and the manner in which the same is to be used, we claim and desire to secure by Letters Patent:

1. In a telephone receiver of the moving coil type including magnetic fields energized by direct current, means for eliminating the disturbing effect of fluctuations of said direct current, said means comprising a conductor, of which said moving coil forms a part, said conductor adapted to be included in the telephone circuit, said conductor being wound in two separate sections, said sections of conductor being respectively subjected to the influence of magnetic fields energized from the same source of current, said two sections of conductor being so electrically connected together that fluctuations of said energizing current are rendered negligible throughout the conductor as a whole.

2. In a telephone receiver of the moving coil type, said receiver including a magnet provided with a substantially annular air gap in which is maintained an intense magnetic field, said magnetic field being produced by direct current flowing through an energizing coil on said magnet, a substantially annular coil disposed to be freely movable in said air gap, said coil attached by a rigid arm to a diaphragm, and means for eliminating the disturbing effect of fluctuations of the direct current energizing said magnet, said means comprising a compensating conductor wound as a coil, said coil being connected electrically in series with said annular coil, and so disposed in a separate magnetic field energized by said direct current that induced electro-motive forces formed in said annular coil by variations of the energizing current are at any instant of

time opposed by equal and opposite electromotive forces in said compensating conductor as hereinbefore described.

3. In a telephone receiver employing magnets energized by direct current, means for eliminating the disturbances in said receiver due to fluctuations of strength of said direct current, said means comprising a conductor wound in two separate sections, said sections being subjected respectively to magnetic fields energized from the same source of current, at least one of said sections being in operative relation with the receiver, and said sections being so electrically connected together that the effects of fluctuations of the energizing direct current are rendered negligible throughout the conductor as a whole.

4. In a telephone receiving instrument, the combination with magnetic fields energized by direct current, of a conductor, said conductor adapted to be included in a telephone circuit, said conductor consisting of more than one section, said sections of conductor respectively subjected to the influence of said magnetic fields, said sections of conductor being so connected together electrically that effects of fluctuations of strength of said magnetic fields are rendered negligible in said conductor, a portion of said conductor being connected by a rigid arm to a diaphragm as hereinbefore described.

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

EDWIN S. PRIDHAM.
PETER L. JENSEN.

Witnesses:
JOHN H. HERRING,
CHARLES PICKLES.

PLAINTIFFS' EXHIBIT NO. 32. 572-573
(Diagram Current Path in Audio Amplifier Output Circuit, Plaintiff's Patent).
This Exhibit referred to in testimony in suit "Dubilier Condenser Corporation, et al., vs. Radio Corporation of America in the District of Delaware".

32

CURRENT PATH IN AUDIO AMPLIFIER OUTPUT CIRCUIT

Nov. 9, 1926. 1,606,212

F. W. DUNMORE ET AL

POWER AMPLIFIER

Filed March 9, 1922

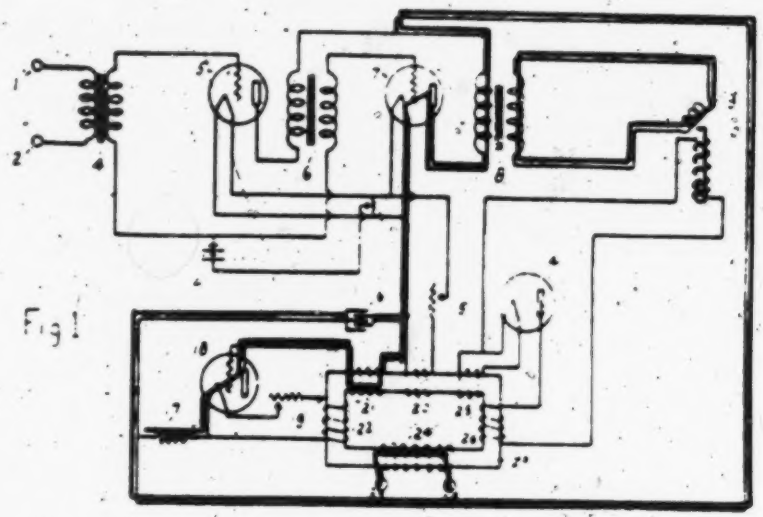


Fig 1

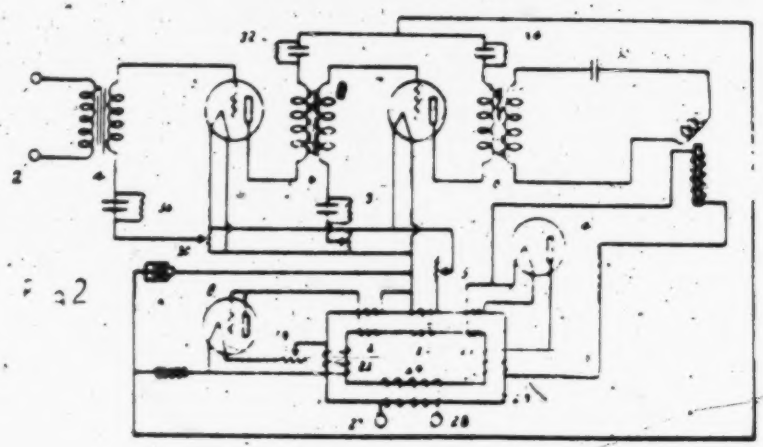


Fig 2

Frances W. Dunmore
Percival S. Lovell
By John B. Brady

574 - 575

PLAINTIFFS' EXHIBIT No. 33.
(Diagram Neutralization of hum in Output Circuit, Plaintiffs' Patent) -- Referred to in testimony in suit "Dubilier Condenser Corporation, et al., vs. Radio Corporation of America in the District of Delaware".

NEUTRALIZATION OF HUM IN OUTPUT CIRCUIT.

Plaintiffs Exhibit No. 33

H. C. Mathes
Clerk

Nov. 9, 1926. 1,606,212

F. W. DURMORE ET AL

POWER AMPLIFIER

Filed March 21, 1922

Fig. 1.

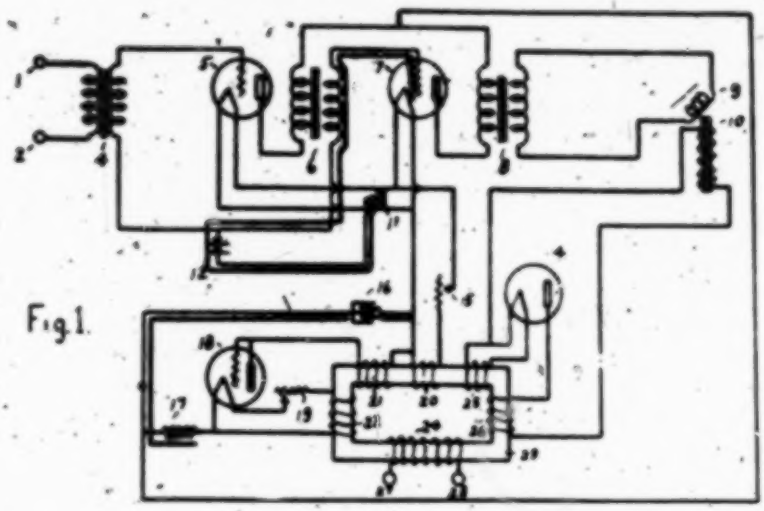
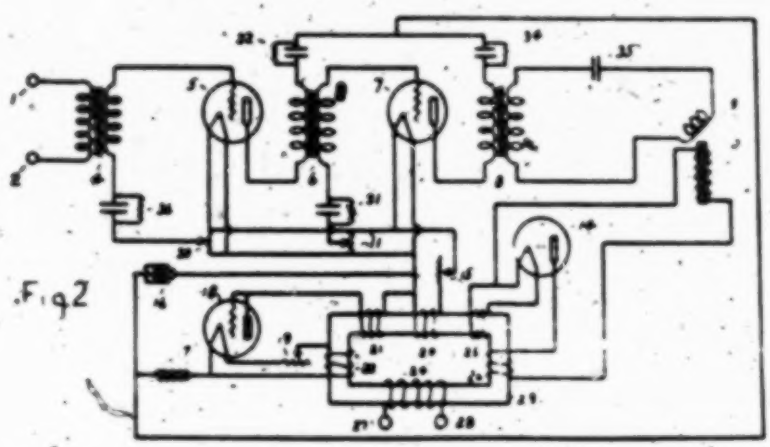


Fig. 2



Inventors
Frances W Dunmore
Pearal E Lovell
By John B Brady
Atty

576–577

PLAINTIFFS' EXHIBIT No. 34.
(Diagram Current Path for field winding Plaintiffs' Patent) -- Referred to in testimony in suit "Dubilier Condenser Corporation, et al., vs. Radio Corporation of America in the District of Delaware."

Plaintiffs Exhibit No. 34
H.C. Mach
Clerk

CURRENT PATH FOR FIELD WINDING

Nov. 9, 1926. 1,606,212

F. W. DUNMORE ET AL

POWER AMPLIFIER

Filed March 21, 1922

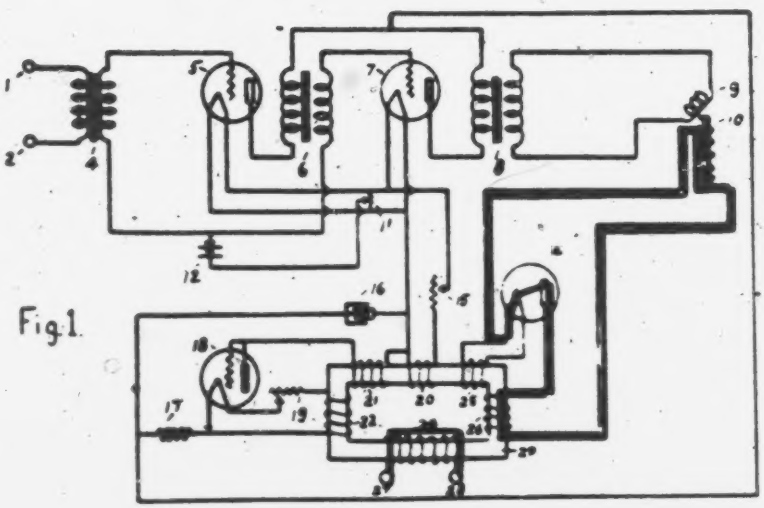


Fig. 1.

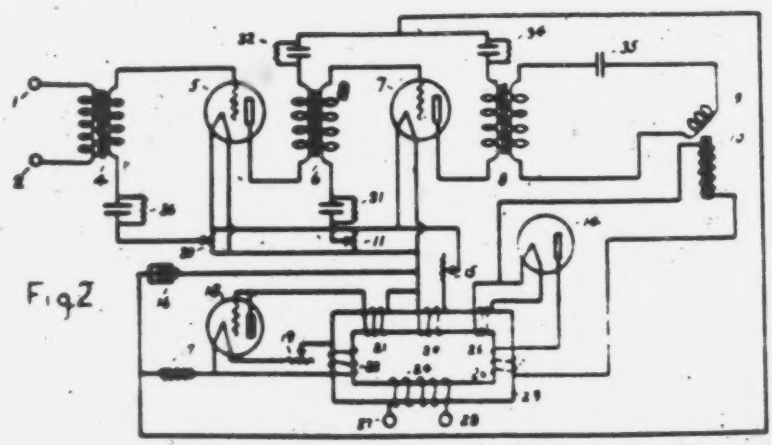


Fig. 2.

Frances W Dunmore
Pearal D Lovell
By John B Brady

PLAINTIFFS' EXHIBIT NO. 35.
(Diagram Neutralization of Hum in Field Winding Circuit, Plaintiffs' Patent) -- Referred to in testimony in suit "Dubilier Condenser Corporation, et al., vs. Radio Corporation of America in the District of Delaware".

578- 579

NEUTRALIZATION OF HUM IN FIELD WINDING CIRCUIT

Plaintiffs Exhibit No. 35
H C Mahaffey
Clerk.

Nov. 9, 1926. 1,606,212

F. W. DUNMORE ET AL

POWER AMPLIFIER

Filed March 21, 1922

Fig. 1.

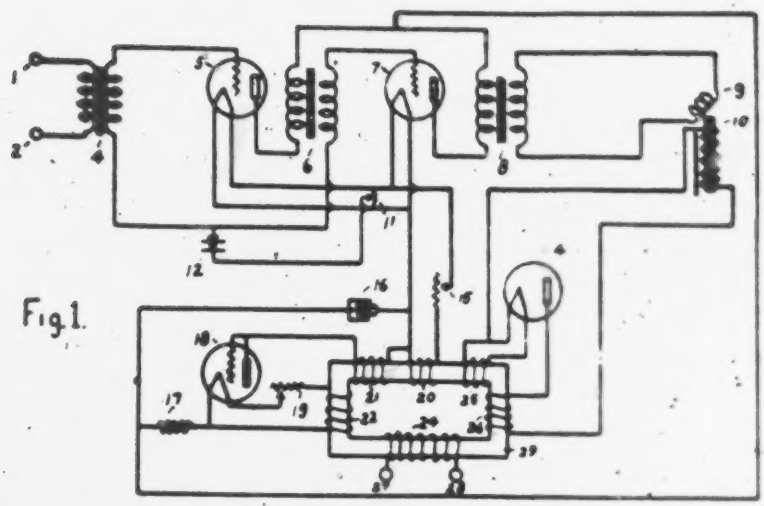
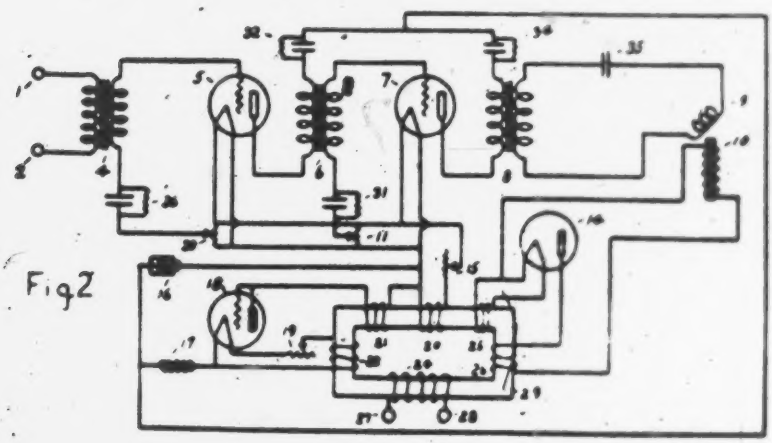


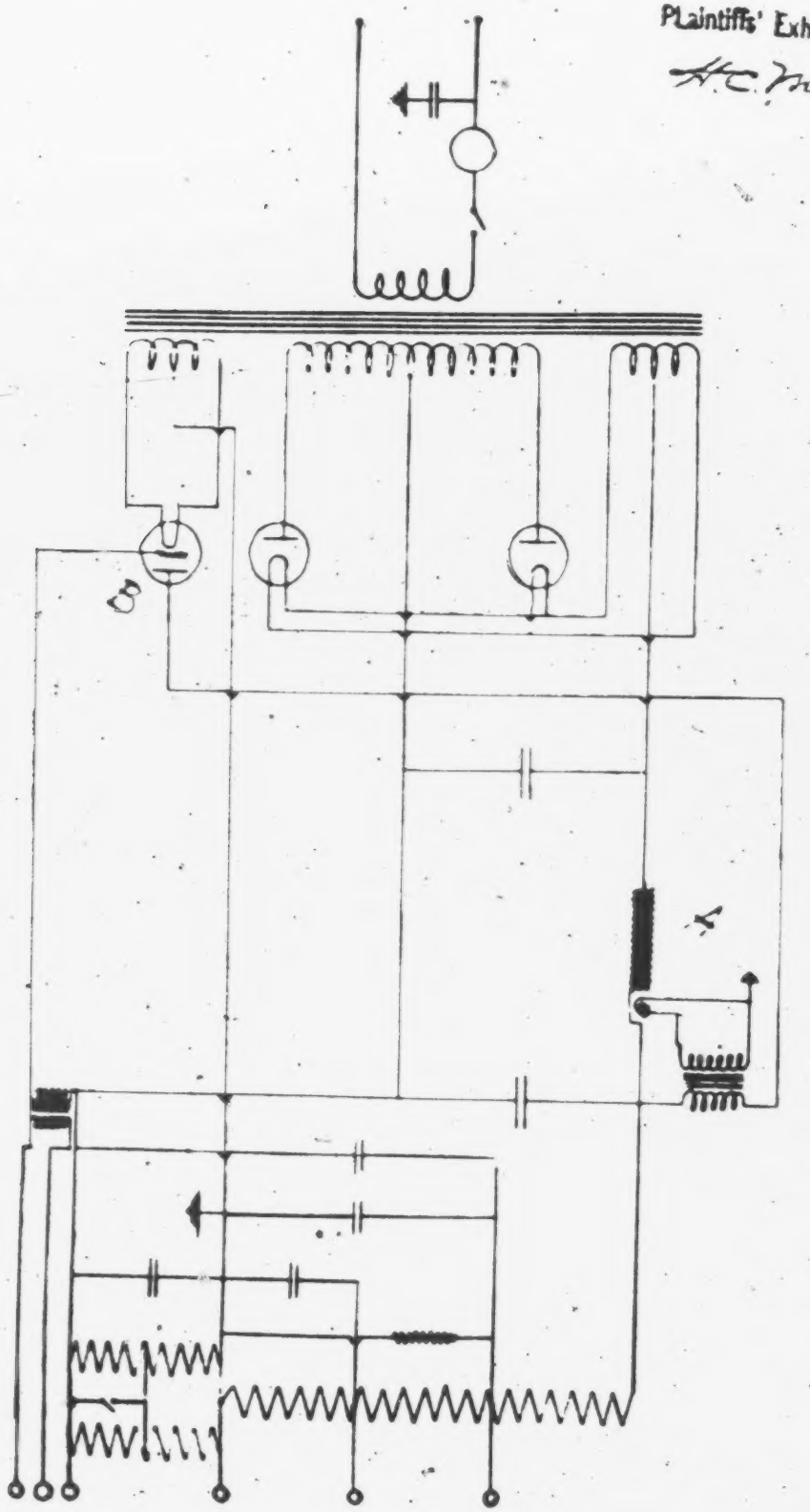
Fig. 2



Inventors
Frank W Dunmore
Orand D Lovell
By John B Brady
Atty.

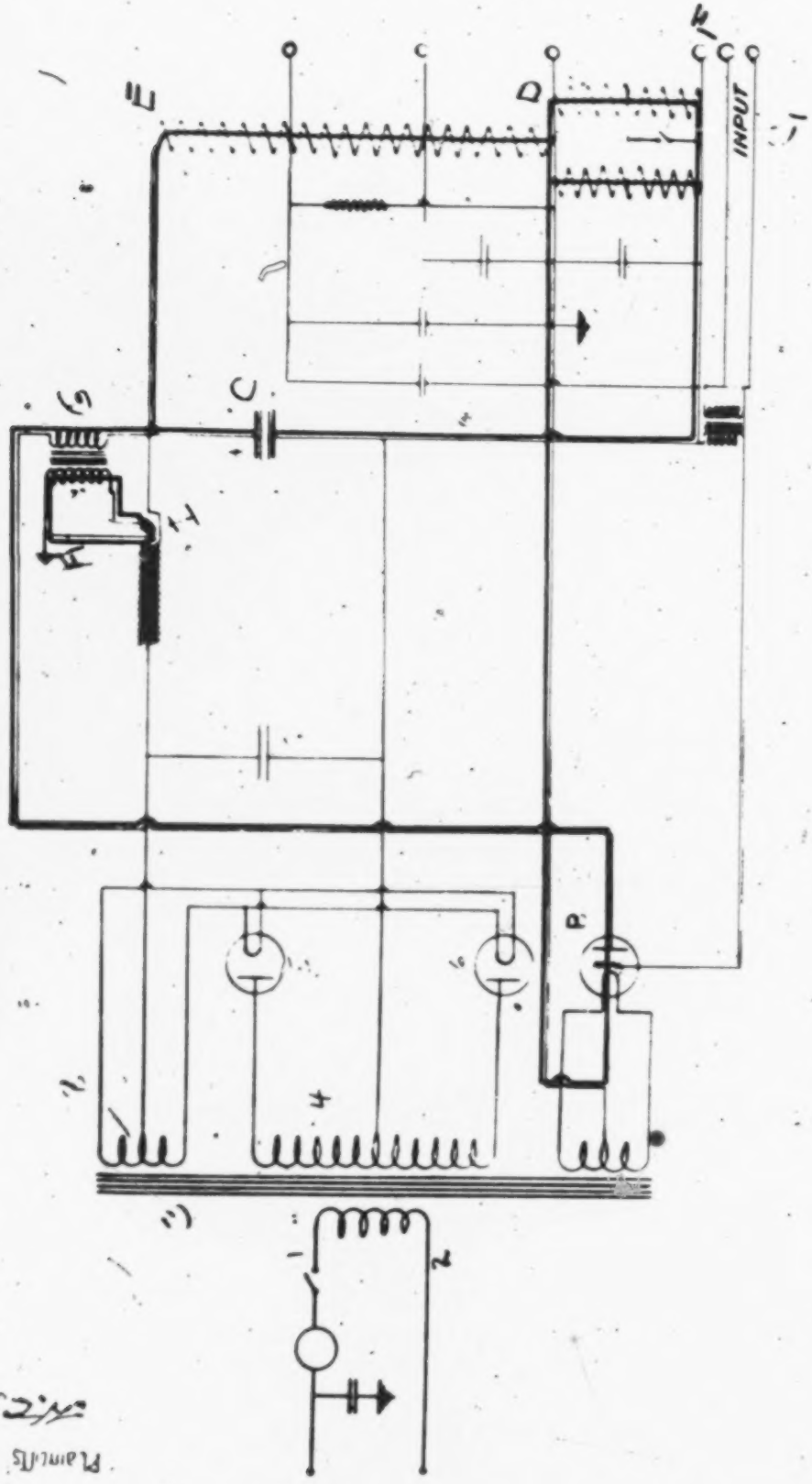
PLAINTIFFS' EXHIBIT NO. 36.
(Diagram Circuit Defendant's Loudspeaker 104)
Referred to in testimony in suit "Dubilier Condenser Corporation, et al., vs. Radio Corp. of America in the District of Delaware.

Plaintiffs' Exhibit No. 36



582 - 583

PLAINTIFFS' EXHIBIT NO. 37,
(Diagram Loudspeaker 104 Current Path in Audio Amplifier Output Circuit). Referred to in testimony in suit "Dubilier Condenser Corporation, et al., vs. Radio Corp. of America in the District of Delaware.



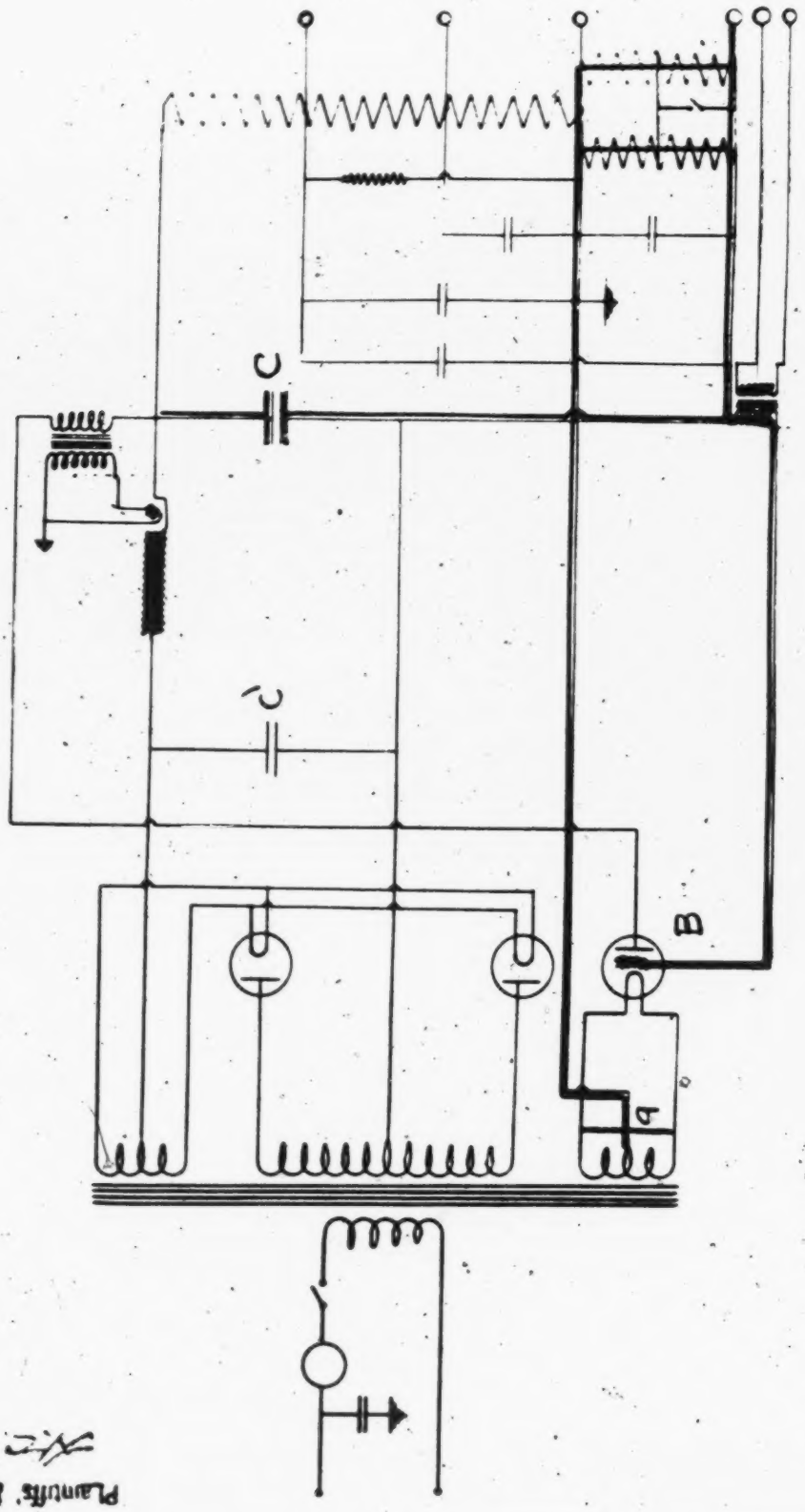
LOUD SPEAKER #104
CURRENT PATH IN AUDIO
AMPLIFIER OUTPUT CIRCUIT.

Clerk

PLAINTIFFS EXHIBIT No. 37

584- 585

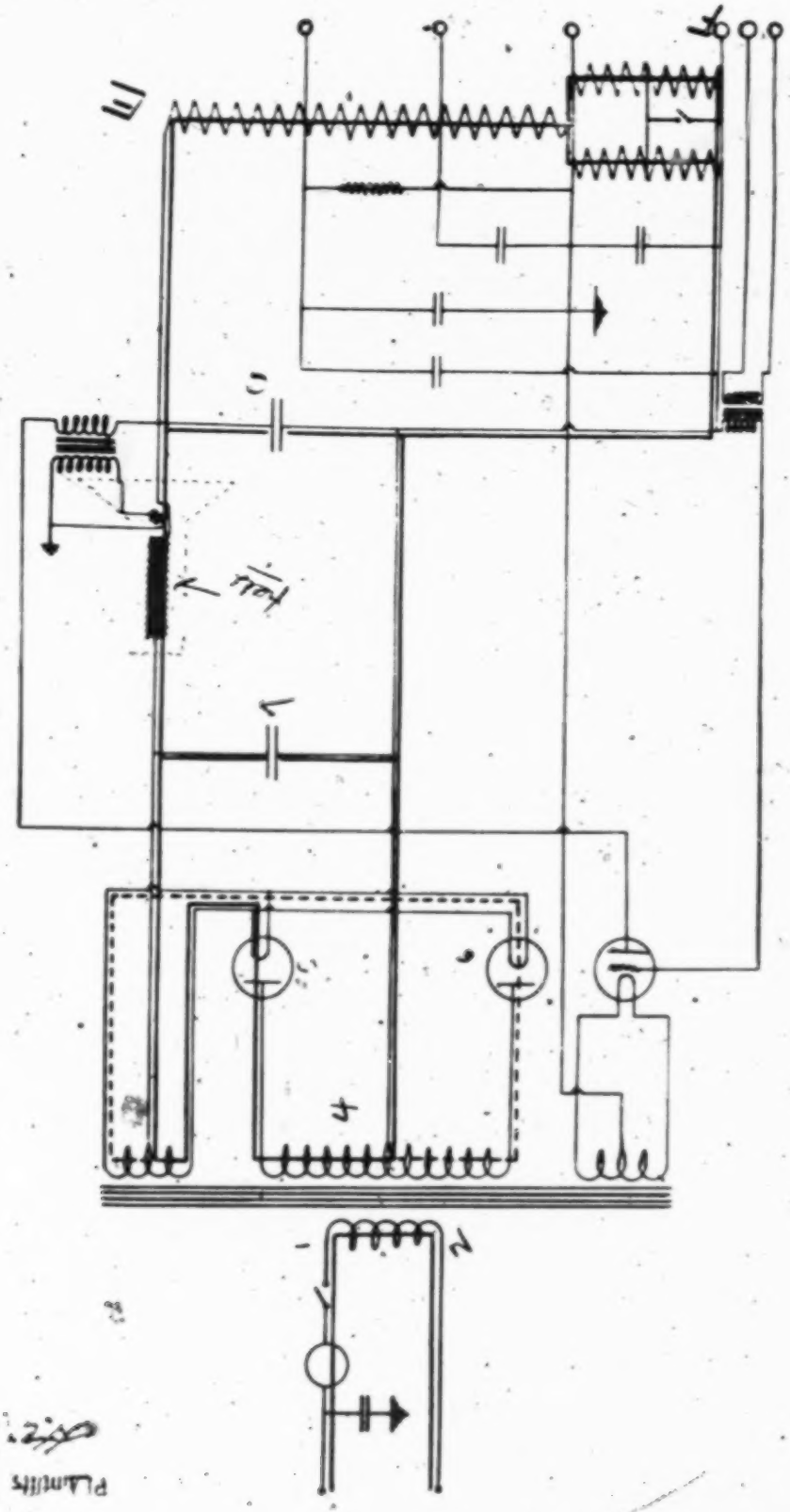
PLAINTIFFS' EXHIBIT NO. 38,
(Diagram Defendants' Loudspeaker 104 Neutralization of Hum in Output Circuit). Referred to in testimony in suit "Dubilier Condenser Corporation, etal., vs. Radio Corp. of America in the District of Del.



LOUD SPEAKER #104.
NEUTRALIZATION OF HUM
IN OUTPUT CIRCUIT.

Plaintiffs' Exhibit No. 38

PLAINTIFFS' EXHIBIT NO. 39.
(Diagram Defendant's Loudspeaker Current Path to Field Winding). Referred to in testimony in suit "Dubilier Condenser Corporation, et al., vs. Radio Corp. of America in the District of Delaware".



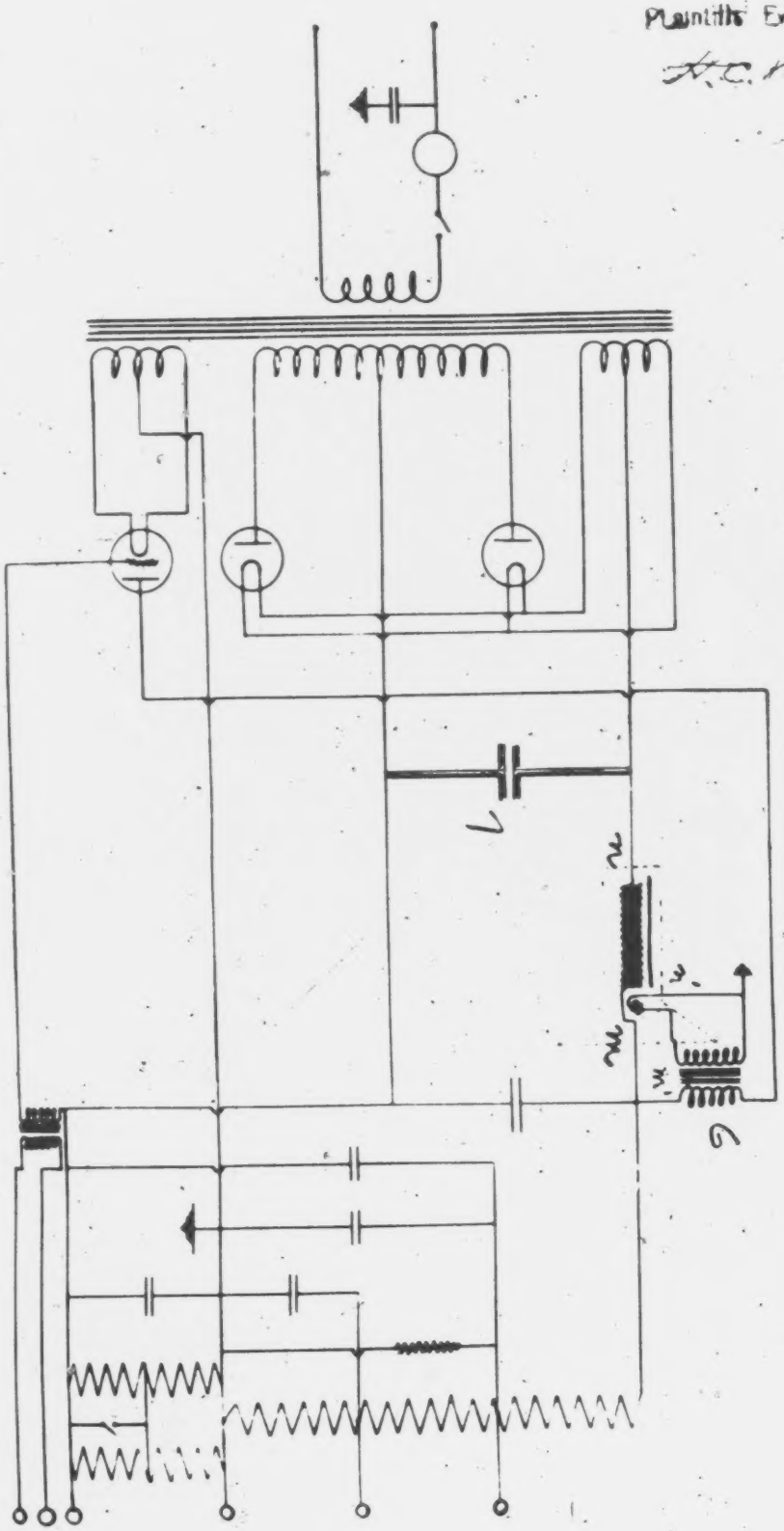
Plaintiffs Exhibit No 39

PLAINTIFFS' EXHIBIT NO. 40.
(Diagram Defendant's Loudspeaker 104, Neutralization of Hum in Field Winding Circuit) Referred to in testimony in suit "Dubilier Condenser Corporation, et al,, vs. Radio Corporation of America in the District of Delaware.

588 — 589

Plaintiffs Exhibit No 40

H.C. [illegible]
Clerk

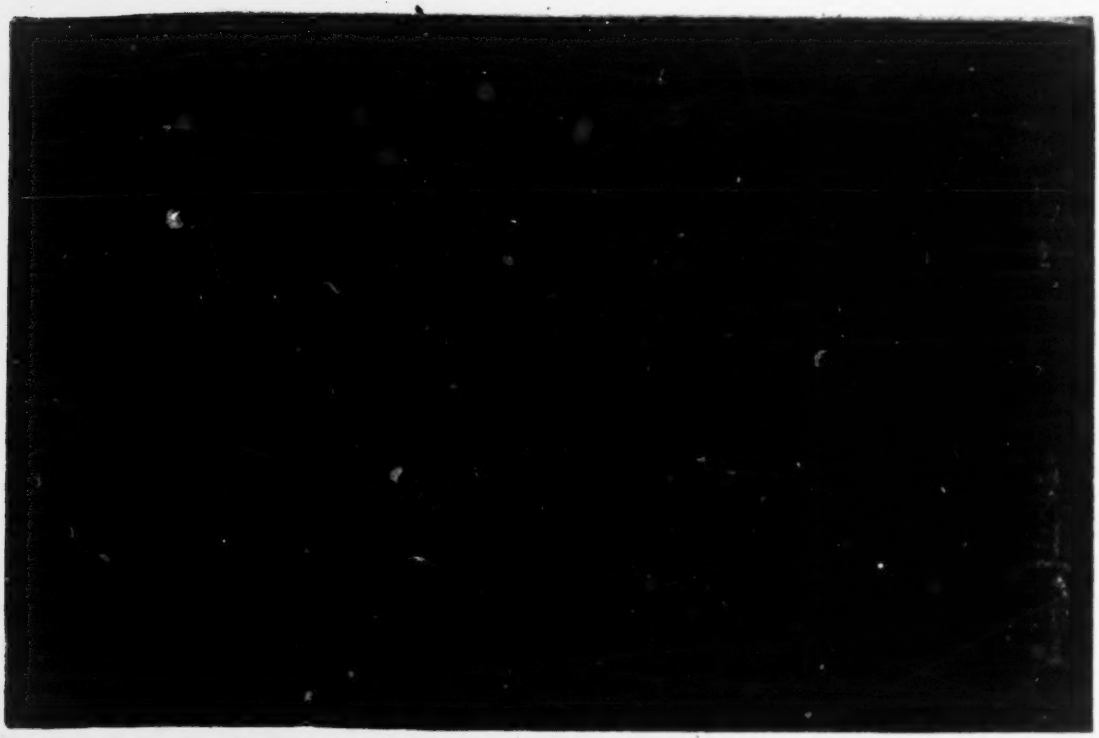


LOUD SPEAKER #104
NEUTRALIZATION OF HUM
IN FIELD WINDING CIRCUIT

DEFENDANT'S EXHIBIT No. 77, Sheet 1.
(Electrical Experimenter, Nov. 1919, pp. 636, 684,
686, 688, "Church Sermon Heard over One-half Mile".

804

590— 591



Recently, in the City of Washington, D. C., a Minister Had the Satisfaction of Broadcasting His Voice Over an Area One Mile in Diameter. His Sermon, Also the Choir and Organ Music, was Thus Heard One-half Mile Away from the Church, Thanks to the Magnavox, the Wonderful Sound Amplifier. People Eight Miles Away Heard the Voice, and it Worked One and One-half Miles Heavierward to an Airplane Flying Overhead.

Church Sermon Heard Over One-Half Mile

HAVE you ever been in the country on a quiet Sabbath morning and endeavored to note how far away from a church you could hear the minister's voice,—or for that matter, the choir singing, or the organ? Not very far you will say, if you have ever tried it. But in Washington, D. C., recently, a minister had the satisfaction of speaking to more people than any other minister, possibly, in church history. His voice, as well as the singing of the choir and the organ music, were amplified to such a tremendous volume, thanks to the newest electro-mechanical amplifier, known as the Magnavox—that the sermon was clearly audible over a circle whose diameter measured one mile, or over an area having a radius of about one-half mile. The Magnavox amplifier, which has been described several times in recent numbers of this journal in connection with public speaking events, was used on the present occasion in connection with a vacuum tube or audion amplifier, which is connected to the microphones and horns; these gathered the sounds of the minister's voice and the choir singing, in the manner here illustrated. The microphones, or sound detectors with the horns, were mounted as inconspicuously as possible about the pulpit and choral gallery, and concealed wires led to the large vacuum tube amplifier, shown in the accompanying illustration at the left. This was in turn connected up with wires and a suitable source of current, which led up to the belfries atop the two church spires, where there were placed on the outside of each belfry two of the Magnavox special amplifiers, fitted with large horns of the type shown at the left of the photograph just mentioned.

The minister spoke in an ordinary tone of voice, and in fact it was somewhat uncanny to be walking down a shady Washington street, when suddenly out of the very air above you, there came the command—"Thou shalt not steal!" in stentorian tones. Verily it sounded as if the prophets had come down to earth, and that the Day of Judgment had surely arrived. While it perhaps would not prove beneficial in a strictly ecclesiastical or religious sense to think of conducting our church services in such a broadcast manner as this, it would not seem a bad idea if in forthcoming years, our churches looked carefully into such matters, and considered the practice of broadcasting their pastors' sermons, organ and choral music by means of telephonic amplifiers, which it would seem, would surely have a beneficial effect and would do no harm, that is certain. Talking on the lighter side, there will probably be but one regret, and that will be on the part of the board of trustees of the church, which let us say has installed at some expense or other of these amplifying outfits. Mr. Stay-at-Home who is enjoying the sermon may make his remittance to the collection basket when His Reverence pronounces the all important words—"The usual Sunday offering will now be received," by contributing a weekly or annual amount for maintaining the equipment and its operating expense? If he heard the sermon.

General Layout of Amplifiers.

Two Magnavox loud-speakers are installed on the belfry of each tower of Trinity Church, corner "U" and Third Streets, Washington, D. C. A special three-step amplifier using a special combined audio and radio frequency circuit, is employed, so arranged that the output is 250 watts of voice modulated current. The input current can be any ordinary telephone current, radio, or the voice, spoken into special transmitters which are attached to the instrument.

Six volts are used on the filaments, and 300 to 600 volts are used on the plate circuits, depending on the volume of sound required. A special set of attachments are furnished, such as a minute transmitter utilizing a silk cord, which can be placed inside of a violin, cello, banjo, or other string musical instrument; also a small transmitter button can be attached to horned or other instruments. Any of these attachments will magnify the original instrument one hundred times by actual measurement.

In the church are installed special transmitters, one along each side of the pulpit, also one for each section of the pipe organ. These transmitters are equipt with papier-maché horns, 18 inches long and 14 inches at the opening of the bell. They will pick up a speaker's voice three to four feet away from the horn and reproduce it faithfully.

Preliminary tests were made with an ordinary watch ticking one of the transmitters, and with the three-step amplifier, the ticking of this watch was heard two blocks away thru normal street traffic. Pipe organ music, choir singing and special solo pieces

(Continued on page 684)

Who wants to be a good Boxer?

Suppose you are walking with your mother, sister, or best girl, and someone passes a slighting remark, won't you be ashamed if you cannot take her part? Well, can you?

Or suppose you remonstrate with a man for striking a smaller man, and the bully turns on you. Can you hold your own? Wouldn't you like to?

Or, if one of your pals says, "Come, put on the gloves and have some fun," can you do it, and get any "fun" out of it?

Less than 2 per cent of all men and boys know anything about the art of self-defense. That means when the test comes, less than 2 per cent are ready. Wouldn't you like to learn to box easily and quickly at half the usual cost?

Marshall Stillman has developed a unique "Shorthand Method" of teaching Boxing. You can learn the fundamentals in six lessons and can outbox older and stronger opponents after two weeks' study. His original principle has enabled him to teach professional boxers difficult blows and guards they could not learn by the old method. Professor Mike Donovan, former middle-weight champion of the world, who taught for thirty years at the New York Athletic Club, endorsed this "Shorthand Method," and helped prepare the lessons we send you. Boxing instructors and Y. M. C. A. physical directors are taking the course to use in their own work. Thousands of men and boys in this country and Canada,—boys as young as 12 and 15, and men as old as 50 and 60 have taken the course both for the boxing instruction and to keep in good physical condition and develop confidence and self-reliance.

It is the first time boxing has been successfully taught by mail, and it is only possible because Marshall Stillman starts with movements you are familiar with—holding out your hand for a coin, the breast stroke in swimming, etc. The first thing you know, he has led you into striking correct blows with both hands, putting the body weight behind them, guarding, ducking, feinting, etc. He teaches you the rudiments in front of your own mirror, before you face your first opponent. When you finally meet an opponent, you know how to hit him, what to expect in return, and how to guard against it.

The special introductory price of the new Home Study Edition is less than you would pay for a single term of lessons by the old method. We will include, until further notice, "Three Rounds of Shadow Boxing," a Jiu Jitsu, or bone-breaking hold and release, and 8 holds in standing wrestling, how to disarm a man, how to get out of dangerous holds, how to guard against a kick for the stomach, etc., and also a complimentary copy of Mike Donovan's famous book "The Science of Boxing." There are 175 illustrations in the course.

Frankly, would you have that much learned all these things by mail, on your own? All right, we will take you at your own ground. We will send the course on 5 days' approval, with the understanding that if you keep it you pay $5. But if you do not want it, you can return it on the fifth day, and end the matter. Simply fill in the coupon—we will do the rest.

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You may send me at once your six-lesson course of instruction in the Shorthand Method of Teaching Boxing, including the three rounds of shadow boxing, Jiu Jitsu, and 8 holds in standing wrestling. I agree to either return the lessons in the fifth day after receiving same, or else send you $5.00 in full payment for the complete course.

Name .....

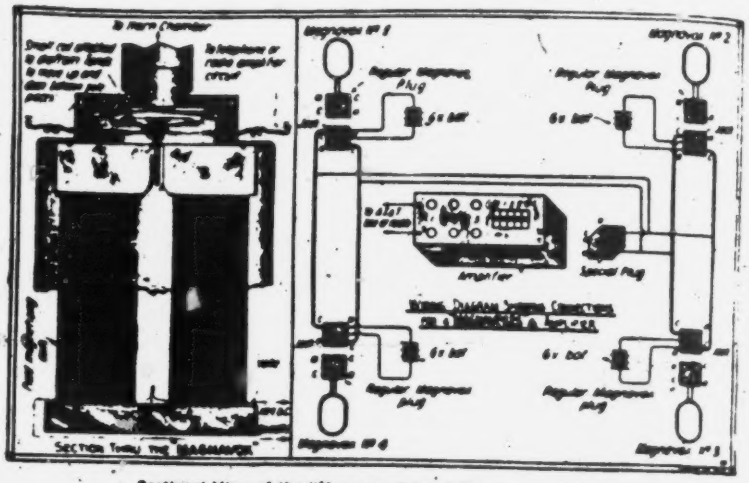
Address .....

Church Sermon Heard Over One-Half Mile

(Continued from page 676)

played on the violin could be heard easily for *half a mile*. Preaching from the pulpit can be heard distinctly for the same distance.

N. Burglund, radio and electrical engineer of the concern manufacturing the Magnavox. Referring to the diagram herewith we see that the remarkable sound-reproducing instrument is of the ...



Sectional View of the "Magnavox" Loud-Talking Amplifier.

This installation was a special test conducted by the Signal Corps, U. S. Army, under the personal supervision of Dr. B. W. Burglund.

The amplifier is so constructed that one, two or three steps may be used. The cam switches on the Bakelite panel are as follows: M, master switch, controlling all currents; 1, 2 and 3 are respectively steps of amplification; R, special switch for "cutting in" a radio winding into the first step and cutting out the voice transmitter. Two binding posts are provided for attachment to any radio detector or telephone circuit.

In the circuit diagram are shown the four Magnavoxes (two for each tower) and a small 6-volt storage battery for exciting the magnetic fields of each Magnavox. This is not necessary unless the Magnavoxes are so far away from the amplifier that the drop of voltage would seriously weaken the fields.

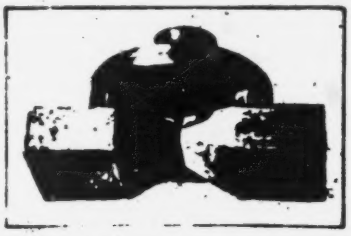
For the sake of portability, special plugs are furnished for connecting to storage batteries (transmitters and plate batteries (90 volts). These are not shown in diagram but attach to the front of the amplifier.

Description of the Magnavox Reproducer.

The ... mechanism of the Magnavox reproducer are available thru the courtesy of Dr. B. ... type, and in this respect differs from the usual telephonic devices intended for reproduction of speech. The ordinary telephone receiver operates on the electro-magnetic principle, whereas variations in the magnetic field act upon a flat iron diafram about two inches in diameter, causing the diafram to be attracted and repelled alternately, so as to cause it to vibrate. The vibrations of the diafram in the well-known manner give rise to air vibrations corresponding to the originating voice waves at the transmitter end of the circuit.

In the Magnavox, the principle is *electro-dynamic*, and the diafram is not acted upon directly by the magnetic flux from the electro-magnet. Instead, a minute insulated wire coil is placed in a small air gap about ... inch long between the pole-

(Continued on page 686)



View Showing Pole Pieces and Diafram of the Magnavox Sound Amplifier. The Diafram Coil Lies Between the Pole Pieces

Handy Binder

for the Electrical Experimenter

65c

DEFENDANTS' EXHIBIT No. 77, Sheet 3

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Church Sermon Heard Over One-half Mile

(continued from page 664)

pieces of the powerful electro-magnet, which pole-pieces are magnetized North and South, as shown in the accompanying drawing. No permanent magnets are used in its make-up. As the fluctuating or alternating currents from the microphone at the distant end of the circuit (or else the oscillatory audio-frequency currents coming from an audion amplifier) are sent thru this small coil attaching to the diafram, the coil is acted upon by the powerful magnetic field between the pole-pieces in such a manner as to be either repelled or attracted alternately (up and down) in a rapid manner, and at a rate corresponding to the voice wave pulsations. The movements of the small coil are, of course, immediately communicated to the diafram, and it is attached firmly to the latter, and in turn the movements of this diafram set up powerful air waves which issue from the sound amplifier horn attached to the instrument, and which is shown in one of our photographs. The odd-shape of this horn has a special bearing on the acoustic quality and sonority of the sound waves its sponsors claim. The upright poles of the electro-magnet have one-inch round cores of annealed Norway iron, the pole-pieces and yoke members being of similar material. The magnetizing coils consume a very small amount of current, or about 25 watts, and they are supplied to operate on 6, 8 or 18-volt D.C. from battery, as desired or on 110 volts D.C.

Contrary to the general opinion, no noticeable effect is caused in these speech reproducers when the latter current is used, due to the *commutator ripple*, owing to the high impedance of the windings, which smoothes out the pulsation so that they are not noticeable at all. Another very interesting feature of the Magnavox, which its inventors have ascertained after careful research on the acoustics of the instrument, is the *diafram*. As is well known, no phonograph or talking machine with a small diafram can be capable of producing the full sonorous quality of the average voice, such as a baritone, and particularly the music from string or wind instruments of the medium or lower tonal register. This is because of the fact that the smaller the diameter of the diafram the higher the natural period or pitch at which the diafram will vibrate, the greater its diameter, within certain limits, of course, the lower the natural period or pitch of the diafram and the more quality will it give to the average class of music, especially vocal or instrumental reproductions in the baritone or base register, for example. So the experts who have designed the Magnavox found that wonderful results were obtained by using a large diafram; in fact, it measures three and one-half inches in diameter. The diafram is neither of iron nor mica, but of German silver, and, furthermore, it is not flat, but has a double curve groove or rib pressed into its surface a short distance from the outer perifery. This helps to stiffen the diafram, and together with the peculiar properties of the material with which it is made, also tends to nullify any effects of natural period vibrations of the diafram itself.

It may be imagined from what has been said before that the new sound, music and speech reproducer must be used with an audion or vacuum tube amplifier—but such is not the case at all. This reproducer

(Continued on page 688)

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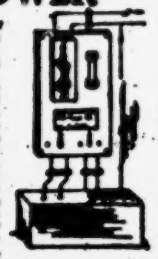

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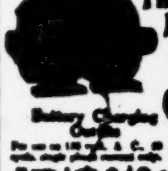

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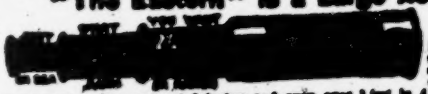


EASTERN NOVELTY CO., 67. 172 E. 93d STREET, NEW YORK.

Church Sermon Heard Over One-Half Mile

(Continued from page 686)

in itself possesses very remarkable amplifying properties and articulates the spoken word very beautifully. It has satisfied the most exacting test of the U. S. Signal Corps at Washington, as well as many experts of the Army and Navy Departments who have heard the instrument and tested it. The loud talker talks in a very loud and clear manner, with no vacuum bulb amplifiers attached. It is simply connected to a microphone, preferably a special microphone designed to be used with it, and comprising four standard microphone buttons connected in parallel, all enclosed in a single casing. In one test made with the instrument in this fashion, using a 12-volt battery current, a single reproducer was successfully employed to talk to 15,000 people, or covering a sound area equivalent to the average city block. In a test made at the Navy Department building at Washington, D. C., Dr. Burghead successfully transmitted the "tick of a watch" so as to be heard *one-half mile away* by experts who were listening for it. These tests proved very interesting, and also the manner of carrying them out. Dr. Burghead hooked up first one stage of a vacuum tube amplifier, and then successive stages. When he hooked on one amplifier he would ask then the Magnavox that the listeners stationed about one-half mile away lift their right arms to a horizontal position if they heard the voice clearly and distinctly, and to raise the arm vertically if they heard the voice extra loud and clear, which was the case when he connected two and three stages of vacuum tube amplifiers into the circuit with the Magnavox. The amplifying horn used in these different tests mentioned has been invariably a 24-inch quarter-sawed oak horn of the particular curved form as shown in the photograph of the instrument.

One of the most astounding features of the Magnavox is that, contrary to what the reader may at first believe, it is possible when the instrument is talking loudly to place the head directly into the horn with no uncomfortable feeling of having your ear drums shattered, or any rocking of the head, as is generally caused by a very loud sound, and at the same time you can walk away one-half mile and still hear the Magnavox talking to you clearly and loudly, and on a quiet day much farther than this. This instrument has many hundred uses, and one of the applications to which it is now being applied is for use on ship-board, and the ships being built by the U. S. Shipping Board are to be fitted with it for the purpose of giving orders from the officers' bridge, or chart house, to the engine room below decks. This has always been one of the most difficult features to install on any vessel, especially on war vessels, where it was imperative that orders should be accurately reproduced and heard at all times. Due to the peculiar construction of the balanced Magnavox microphone, which has found wide application in Aeroplane Radio telephony and the Magnavox itself, either of these instruments can be used where there is a perfect medium of noise, such as created by the turbine and dynamo running in the engine room, and the noise of other auxiliary machinery, without there being the least effect on the telephonic transmitting and reproducing qualities of the apparatus. In fact, in one instance, the Magnavox was fastened on the reduction gear case of a turbo-generator on a war ship. This, we must concede, is the acid test of any telephonic device

[fols. 598 & 599] DEFENDANTS' EXHIBIT No. 78

(Pridham and Jensen, U. S. Patent 1,105,924, Aug. 4, 1914, referred to in suit "Dubilier Condenser Corporation et al., vs. Radio Corp. of America, in District of Delaware)

This Exhibit is the same as Defendants' Exhibit "F" offered in the present case, and is incorporated in this Volume of Exhibits at page 566, etc.

DEFENDANT'S EXHIBIT No. 79,
(Simplified Schematic Diagram Radiola 28 connected to speaker, Model 104). Referred to in testimony in suit "Dubilier Condenser Corporation, et al., vs. Radio Corp. of America in Dist. of Delaware.

600-6

SIMPLIFIED SCHEMATIC DIAGRAM
RADIOLA 28 CONNECTED TO SPEAKER MODEL 104

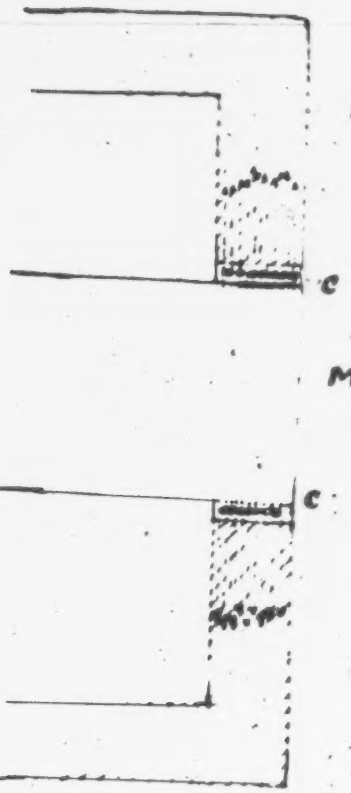
○ Located in AC Package

DEFENDANT'S EXHIBIT NO. 80.
(Waterman Diagrammatic Sketch 104 Speaker Floating Coil Location). Referred to in testimony in suit "Dubilier Condenser Corporation, et al., vs., Radio Corp. of America in District of Delaware.

Defendant's Exhibit No 80.

H.C.M.

Clerk.



Diagrammatic Sketch
104 Speaker Floating
Coil Location

[fols. 604 & 605] Clerk's Certificates to foregoing record omitted in printing.

Endorsed on cover: File No. 39,942. U. S. Circuit Court of Appeals, Fourth Circuit. Term No. 388. A. G. Triplett, R. M. Triplett, A. Nelson, et al., petitioners, vs. Percival D. Lowell, Francis W. Dunmore, and Dubilier Condenser Corporation. Petition for writ of certiorari and exhibit thereto. Filed August 21, 1935. Term No. 388, O. T., 1935.

(7302-C)